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Scientific, Technical and Economic Committee for Fisheries (STECF)

Assessment of Mediterranean Sea stocks - part 2 (STECF-11-14)

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This report was reviewed by the STECF during its 38th plenary meeting held from 7 to 11 November, 2011 in Brussels, Belgium

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

Assessment of Mediterranean Sea stocks - part 2 (STECF 11-14)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN BRUSSELS 7-11 NNOVEMBER 2011

Request to the STECF

STECF is requested to review the report of the **EWG-11-12** held from 26 – 30 September in Larnaca, Cyprus, to evaluate the findings and make any appropriate comments and recommendations.

Introduction

The report of the Expert Working Group on Assessment of Mediterranean Sea stocks - part 2 (STECF-11-12) was reviewed by the STECF during its 37th plenary meeting held from 7 to 11 November, 2011 in Copenhagen, Denmark. The following observations, conclusions and recommendations represent the outcomes of that review.

STECF OBSERVATION

STECF notes that all ToRs were addressed. The major ToRs (A-E) were addressed through the assessments of 25 Mediterranean exploited stocks and fisheries, as supported by data obtained through the 2011 DCF data call for the Mediterranean and the Black Sea. Exploitation status for all stocks that were assessed was evaluated against the proposed F_{MSY}. The assessments and management advice provided in the present report are limited to the Geographical Sub-areas (GSAs) off Spain, Italy, Malta and Cyprus; no experts from France, Slovenia and Greece attended the meeting.

STECF also notes that EWG 11-12 devoted considerable time at the meeting to evaluate the quality of the data submitted by Member States in response to the DCF Mediterranean data call in 2011 (ToR F). The STECF-EWG-11-12 Working Group Report contains findings for further consideration by DG Mare.

The EWG 11-12 updated the discussion on the evaluation of mixed fisheries frameworks and computer software to deliver mixed fisheries management advice under various scenarios. As many of the Mediterranean fisheries are indeed classified as mixed fisheries, this specific issue is considered very important and shall be further elaborated during future meetings.

Further development and testing of R scripts to facilitate the consistent analysis of MEDITS and other CPUE data series was accomplished. ToR L covering all other business was dedicated to the evaluation of the influence of sea-bottom temperature on trawl swept-area estimations and to improvement of fishing effort descriptors. The EWG also focused on a detailed explanation of the technical meaning and correlation of mesh size opening and stretched mesh size and among different ways of expressing the twine thickness. A preliminary evaluation of the Maltese fisheries management plans was also undertaken and an attempt was made to replicate economic analysis as regularly performed at MS level in the annual economic report (AER 2010), but at a finer regional (GFCM SA) and fisheries' specific disaggregation level.

STECF CONCLUSIONS

Of the 24 stocks assessed by the EWG, 21 were classified as being subject to overfishing, while only 3 stocks were found sustainably fished in relation to the proposed management reference points consistent with high long term yields (F_{MSY}). The assessment of one of the stocks was inconclusive due to data deficiencies.

STECF draws the following conclusions based on the work of the EWG-11-12.

- two stocks in GSA 01, European hake (*Merluccius merluccius*) and red mullet (*Mullus barbatus*) are subject to overfishing.

- three stocks in GSA 06, European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*) and pink shrimp (*Parapaeneus longirostris*) are subject to overfishing

- stocks in GSA 09 differ in their exploitation status. Ten stocks, European hake (*Merluccius merluccius*), blue and red shrimp (*Aristeus antennatus*), giant red shrimp (*Aristaeomorpha foliacea*), spottail mantis shrimp (*Squilla mantis*), Norway lobster (*Nephrops norvegicus*), red mullet (*Mullus barbatus*), striped red mullet (*Mullus surmuletus*), European anchovy (*Engraulis encrasicolus*), common pandora (*Pagellus erythinus*) and blackmouth catshark (*Galeus melastomus*) are subject to overfishing. The stock of pink shrimp (*Parapaeneus longirostris*) is assessed as sustainably fished.

- giant red shrimp (*Aristaeomorpha foliacea*) in GSA 11 is subject to overfishing.

- three stocks in GSAs 15 and 16, giant red shrimp (*Aristaeomorpha foliacea*), red mullet (*Mullus barbatus*) and common Pandora (*Pagellus erythinus*) are subject to overfishing.

- sardine (*Sardina pilchardus*) in GSA 16 is considered to be sustainably fished, whereas anchovy (*Engraulis encrasicolus*) in the same GSA is subject to overfishing.

- common sole (*Solea solea*) in GSA 17 is subject to overfishing.

- picarel (*Spicara smaris*) in GSA 25 is currently being fished at a sustainable rate but the biomass estimated is below the B_{MSY}.

STECF endorses the findings and conclusions of the Report of the STECF-EWG 11-12.

STECF RECOMMENDATIONS

As a result of its review of the Report of the STECF-EWG 11-12 on assessment of Mediterranean stocks, the STECF has drawn the following recommendations:

1. The EWG was specifically requested to scrutinize the quality, consistency and completeness of the official Mediterranean DCF data call in the different GSAs. STECF recommends that the detailed comments by EWG 11-12 concerning quality and completeness of the national submissions to the 2011 Mediterranean DCF data call should be noted by DG Mare and communicated to the national correspondents of the Member States' DCF program.

2. STECF notes that since 2008, progress on Terms of Reference relating to bioeconomic modelling has been poor both in terms of data and models used. STECF thus recommends that bioeconomic modelling is dealt with either in a specific ad-hoc working group (i.e. outside the EWG stock assessment meetings) or within the EWGs dealing with economic issues.

EXPERT WORKING GROUP REPORT

REPORT TO THE STECF

EXPERT WORKING GROUP ON Assessment of Mediterranean Sea stocks - part 2 (STECF EWG 11-12)

Larnaca, Cyprus, 26-30 September 2011

1 EXECUTIVE SUMMARY

The STECF EWG 11-12 met in Larnaca (Cyprus), 26-30 September 2011 to continue STECF efforts regarding its mandate for Mediterranean stock and fisheries assessments. The meeting was chaired by Massimiliano Cardinale and attended by 23 experts in total, including 5 STECF members, 3 JRC experts and one representative of DG Mare.

The major ToRs (A-E) was addressed through the assessments of 25 Mediterranean exploited stocks and fisheries, as supported by the data obtained by the 2011 DCF data call for the Mediterranean and the Black Sea. The assessments of recent and historic stock parameters and fisheries as well as management advice provided in the present report is constrained for the Geographical Subareas (GSA) off Cyprus, Italy, Malta, and Spain, as no experts from France, Greece and Slovenia attended the meeting. The assessments of exploited stocks and fisheries revealed the stocks' exploitation status which was evaluated against the proposed F_{MSY} limit considered consistent with high long term yields and low risk of fishery collapse.

The STECF EWG 11-12 devoted considerable time of the meeting to evaluate the quality of the data submitted by Member States in response to the DCF Mediterranean data call in 2011 (ToR F). The present report contains certain findings for further consideration by STECF and DG Mare.

ToR G focused on the task of the development of appropriate biological indicators and methods for stock assessments standard could not be covered. Input data was addressed by the evaluation of the SEINE method to a number of Mediterranean stocks. The discussion was initiated during the previous meeting EWG 11-05.

ToRs H covered further development and testing of R scripts to facilitate the consistent analysis of MEDITS datasets. The script was used in preparation of the meeting to perform data quality checks for meaningfulness of requested parameters (swept area, haul duration, wing opening, etc). The verification of haul position was done jointly with the testing of the CPUE for one test species. An additional functionality added to the R script is a statistical age slicing function, which can also be used on DCF landing data. Finally a comparison between the capabilities Trawl Surveys Information Systems (ATrIS) and the R script was performed.

The EWG 11-12 updated the discussion on the evaluation of mixed fisheries frameworks and computer programs to deliver mixed fisheries management advice under various scenarios (ToR I). As many of the Mediterranean fisheries are indeed classified as mixed fisheries, this specific issue is considered very important and shall be continued during the forth-coming meetings. The application of a stochastic medium term forecast model, previously presented during EWG 11-05, was conducted.

Under ToR K, the EWG 11-12 discussed and revealed topics of the following-up EWG meeting within the STECF framework and related logistics.

ToR L covering all other business was dedicated to the evaluation of the influence of sea-bottom temperature on trawl swept-area estimations and to improvement of fishing effort descriptors. Estimation of swept area in MEDITS survey was also examined in general in this ToR. The ToR also focused on a detailed explanation of the technical meaning of mesh size opening and stretched mesh size. Under the same ToR L, the EWG 11-12 concluded a preliminary evaluation of the Maltese fisheries management plan. EWG 11-12 also tried to replicate economic analysis as regularly performed at MS level in the annual economic report (AER 2010), but at a finer regional (GFCM SA) and fisheries' specific disaggregation level.

2 CONCLUSIONS OF THE WORKING GROUP

ToR A-E update and assess historic and recent stock parameters: The EWG 11-12 undertook 25 detailed approaches to assess the status of exploited demersal Mediterranean resources and their fisheries. The EWG 11-12 provided short summary sections for 24 stocks informing about the stocks' status and their state of exploitation in relation to proposed management reference points consistent with high long term yields (F_{MSY}). The assessment of European hake (*Merluccius merluccius*) in GSA 11 was inconclusive due to data deficiencies. Among the 24 assessed stocks, 21 were classified as being subject to overfishing while only 3 stocks were found sustainably fished.

The STECF EWG 11-12 advised that fisheries of demersal stocks shall reduce their fishing effort to achieve sustainable exploitation, in particular for the trawl fleet. Furthermore, the STECF EWG 11-12 advises that fishing effort reductions of demersal fisheries shall be considered in the framework of multi-annual plans. This advice reflects the fact that Mediterranean demersal fisheries are characterized by a pronounced multi-species/stocks catch profile, while each of the species/stocks has different management and conservation requirements. STECF EWG 11-12 also stresses that most of the demersal fisheries exploit mainly juveniles of different species and stocks. The STECF EWG 11-12 also reiterates its advice that effort management of fisheries targeting small pelagics implies a high risk due to the schooling behavior of such species and the multi-species character of their fisheries (changing target species as available and appropriate). Therefore, STECF EWG-11-12 recommends the consideration of landing restrictions (e.g. TAC) as a more effective management tool for fisheries of small pelagic species in the Mediterranean.

The STECF EWG 11-12 concludes that:

- two stocks in GSA 01, European hake (*Merluccius merluccius*) and red mullet (*Mullus barbatus*) are subject to overfishing.

- three stocks in GSA 06, European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*) and pink shrimp (*Parapaeneus longirostris*) are subject to overfishing

- stocks in GSA 09 differ in their exploitation status. Ten stocks, European hake (*Merluccius merluccius*), blue and red shrimp (*Aristeus antennatus*), giant red shrimp (*Aristaeomorpha foliacea*), spottail mantis shrimp (*Squilla mantis*), Norway lobster (*Nephrops norvegicus*), red mullet (*Mullus barbatus*), striped red mullet (*Mullus surmuletus*), European anchovy (*Engraulis encrasicolus*), common pandora (*Pagellus erythinus*) and blackmouth catshark (*Galeus melastomus*) are subject to overfishing. The stock of pink shrimp (*Parapaeneus longirostris*) is assessed as sustainably fished.

- giant red shrimp (*Aristaeomorpha foliacea*) in GSA 11 is subject to overfishing.

- three stocks in GSAs 15 and 16, giant red shrimp (*Aristaeomorpha foliacea*), red mullet (*Mullus barbatus*) and common Pandora (*Pagellus erythinus*) are subject to overfishing.

- **s**ardine (*Sardina pilchardus*) in GSA 16 is considered to be sustainably fished, whereas anchovy (*Engraulis encrasicolus*) in the same GSA is subject to overfishing.

- common sole (*Solea solea*) in GSA 17 is subject to overfishing.

- picarel (*Spicara smaris*) in GSA 25 is sustainably fished but the biomass estimated is below the B_{MSY}.

ToR F Quality and completeness of the official Mediterranean DCF data call: The STECF EWG 11-12 scrutinized the data obtained from the 2011 DCF Mediterranean data call for consistency and completeness in different GSAs as supported by a JRC data coverage report. Specific data deficiencies are described in the various sections of detailed stock and fisheries assessments.

ToR G Empirical biologic indicators and methodologies for stock assessments lacking standard data requirements: STECF EWG 11-12 further discussed the SEINE method for estimating total mortality (Z) for several species historically not assessed in GSA 09 using a mean length approach derived by Gedamke & Hoenig (2006), which does not require equilibrium conditions. STECF EWG 11-12 concludes that for species where both juveniles and adults are effectively sampled by the gear, the SEINE method has the potential to provide a robust estimate of Z and detect eventual temporal changes in mortality rates.

ToR H Computer program R-scripts to evaluate MEDITS and other CPUE data series: STECF EWG 11-12 further developed the R-script to facilitate the data quality, exploration and survey index standardization of MEDITS survey. A new statistical age slicing function was implemented. The R script can perform a deterministic slicing on MEDITS data maintaining the spatial disaggregation level of hauls or perform statistical slicing on DCF landing numbers at length or on aggregated MEDITS data. Such additional capability, if adopted as a standard tool for data processing, pending further testing, may result in a significant efficiency improvement and a standardized interpretation of catch at length data.

The comparison between the R script and Adriamed Trawl Surveys Information Systems (ATrIS) revealed that the two tools are fundamentally different as the first is a statistical platform for data extraction and modelling while the second is a database with data exploration routines. Potentially, linking the two tools could largely expand the capability of ATrIS.

STECF EWG 11-12 advises to further improve the R-scripts during the follow-up meetings, but also to arrange a training course for users so that the scripts will be of easier use to EWG participants. In particular it is recommended to test the new slicing function and assess what is the impact on the XSA assessment results.

ToR I Frameworks to deliver management advice for multi-species/stocks fisheries: The working group constantly noted that the great majority of Mediterranean stocks are exploited by multi-species (mixed) fisheries, particularly demersal species, mainly due to the poor selectivity of many gears used. The variety of exploited stocks in mixed fisheries still requires specific conservation needs as defined by the Marine Strategy Framework Directive (EU 2008, EU COM 2011). STECF EWG 11-12 further noted that the selection of the various mixed fisheries involved in the exploitation of certain stocks potentially varies with the areas, gears and the fishing strategies applied. The group emphasized the relevance of tools with different potential options to guide management and to design multiannual management plans towards sustainable fisheries. STECF EWG 11-12 introduced then a stochastic medium term forecast model for mixed fisheries (maximum 10 stocks, 10 fisheries) which provides quantitative conclusions on future catch and biomass trends under various management scenarios over medium term (10 years). The model is age specific and thus capable to consider fisheries specific exploitation patterns and temporal changes of them. A simulation of the mixed fisheries on GSA 09 was conducted using data of four fisheries being jointly involved in exploitation of seven stocks.

STECF EWG 11-12 advises that the potential use of existing devices to improve the selectivity of mixed fisheries shall be evaluated and promoted in order to simplify overly complex fisheries strategies through reduction of the number of species exploited by the same gear.

ToR K Future planning of Mediterranean expert group meetings: the STECF expert meeting in 2011 (STECF EWG 11-20: Assessment of Mediterranean Sea stocks - part 3), previously being planned for the period 12-16 December 2011, is postponed and will be organized from 16-20 January 2012 in Madrid.

ToR L Other Business - Influence of sea-bottom temperature on trawl swept-area estimations and advice on technical significance of mesh size characteristics: STECF EWG 11-12 investigated the effect of temperature on speed sound and then on gear openings and swept-area. The STECF EWG 11-12 also focused on a detailed explanation of the technical meaning and correlation of mesh size opening and stretched mesh size and among different ways of expressing the twine thickness.

ToR L Other Business - Assessment of Malta fisheries management plan: STECF EWG 11-12 provisionally evaluated the Maltese fisheries management plan (MP). STECF EWG 11-12 noted that the information on stock status of the species targeted by the different fleets and on the impact of the fishing activity is limited. STECF EWG 11-12 agreed with the priority given in the MP to establishing monitoring programs and stock assessments in the future.

Three derogations were cited in the MP regarding the use of a traditional boat seine ("tartarun"). The gear is hauled by hand and it is estimated to be used only over 1.1% of the *Posidonia* meadows. No information is given on the status of the stocks exploited by this fisheries. However, STECF EWG 11-12 noted that this fishery is conducted within a limited area (i.e. one single bay) and during a limited part of the year (mid-June to end August). Moreover, STECF EWG 11-12 noted that this gear is not allowed by Maltese legislation to touch the *Posidonia* beds and therefore may qualify for the derogation for this gear operating over *Posidonia* meadows.

The management plan reports that trawling is carried out in rocky bottoms (50 - 150 m). STECF EWG 11-12 highlighted that there is no information on the type and fragility of habitats impacted by this activity and no planned action is foreseen to avoid any possible damage caused by the bottom trawl gear to these hard bottoms.

The management plan did not include the socio-economic impacts of the proposed management measures. STECF EWG 11-12 supported the provision of the proposed MP to tackle socio-economic evaluations of any planned measures.

ToR L Other Business – Attempt of economic analysis of the EU Mediterranean fishing fleets at GFCM Sub-Area (GSA) level: STECF EWG 11-12 performed the economic analysis at GFCM GSA level by analogy to the economic study regularly performed at MS level and available in the annual economic report (AER 2010). An attempt to estimate the same indicators and outputs in terms of figures and tables was carried out.

3 RECOMMENDATIONS OF THE WORKING GROUP

No specific recommendations are provided by the STECF EWG 11-12.

4 INTRODUCTION

The expert working group on Mediterranean stock and fisheries assessment STECF EWG 11-12 held its second out of three meetings planned in 2011 on Larnaca, Cyprus, 26-30 September 2011. The chairman opened the meeting at 9.00 am on Monday, 26 September 2011, and adjourned the meeting by 5.00 pm on Friday, 30 September 2011. The meeting was attended by 23 experts, including 5 STECF members and 3 JRC experts. Franco Biagi represented DG Mare.

The structure of the present report is in accordance with the terms of reference to STECF, as defined in the following chapter.

4.1 Terms of Reference for EWG 11-12

The STECF is requested to

a) update and assess historic and recent stock parameters for the longest time series possible of the species listed below and parameters of their fisheries (by fleets) by all relevant individual GSAs in the Mediterranean Sea or combined GSAs where appropriate, with emphasis on stocks not yet assessed analytically. Assessment data and methods are to be fully documented with particular reference to the completeness and quality of the data submitted by Member States as response to the official Mediterranean DCF data call issued on August 2011. To the extent possible, the assessment shall provide the target (biological, bio-economic), the precautionary (threshold) and conservation (limit) reference points, either model based or empirical. Data collected outside the DCF and/or delivered to the meeting by non-EU scientists shall be used as well and merged with DCF data whenever necessary. Due account shall also be given to data used and assessments carried out by the FAO-regional projects co-funded by the European Commission and EU-Member States.

- •Sardine (*Sardina pilchardus*)
- •Anchovy (*Engraulis encrasicolus*)
- •European hake (*Merluccius merluccius*)
- •Common sole (*Solea solea*)
- •Red mullet (*Mullus barbatus*)
- •Deep-water rose shrimp (*Parapenaeus longirostris*)
- •Red shrimp (*Aristeus antennatus*)
- •Giant red shrimp (*Aristaeomorpha foliacea*)
- •Norway lobster (*Nephrops norvegicus*)

b) assess historic and recent stock parameters for the longest time series possible of the other species listed in Annex 7 of the DCF data call issued on August 2011. Parameters of their fisheries (by fleets) by all relevant individual GSAs in the Mediterranean Sea, or combined GSAs where appropriate, shall be provided as well. Assessment data and methods are to be fully documented with particular reference to the completeness and quality of the data submitted by Member States as response to the official Mediterranean DCF data call issued on August 2011. To the extent possible, the assessment shall provide the target (biological, bio-economic), the precautionary (threshold) and conservation (limit) reference points, either model based or empirical. Data collected outside the DCF and/or delivered to the meeting by non-EU scientists shall be used as well and merged with DCF data whenever necessary. Due account shall also be given to data used and assessments carried out by the FAO-regional projects co-funded by the European Commission and EU-Member States.

c) review of assessments of historic and recent stock parameters of demersal and small pelagic species listed under a) and b) and assessments of their fisheries in the Mediterranean Sea as conducted by other scientific frameworks including also national frameworks of non-EU countries. Due account shall also be given to data used and assessments carried out by the FAO-regional projects co-funded by the European Commission and EU-Member States.

d) assess, propose and review biological fisheries management reference points, either model based or empirical, of exploitation and stock size related to high yields and low risk of fishery collapse in long term of each of the stocks listed under a), b) and c) and assessed by STECF or other scientific frameworks. This work shall provide, to the extent possible, the target (biological, bio-economic) for sustainable fishing at MSY or proxy, the precautionary (threshold) and conservation (limit) reference points. Assessment data and methods are to be fully documented with particular reference to the completeness and quality of the data submitted by Member States as response to the official Mediterranean DCF data call issued on August 2011.

e) advise on the recent status of exploitation and stock size of the species listed under a), b) and c) in relation to the biological fisheries management reference points as identified under d).

f) review the quality and completeness of all data resulting from the official Mediterranean DCF data call issued on August 2011. STECF is requested to summarize and concisely describe in detail all data quality deficiencies of relevance for the assessment of stocks and fisheries. Such review and description are to be based on data reformatted to the revised data format of DCF data calls for the Mediterranean and Black Seas as compiled and provided by JRC in accordance with the STECF advice from the plenary held during 11-15 April 2011. The description will support further reconciliation of national DCF programs.

g) test the empirical biologic indicators and methodologies for their calculation recommended by STECF SGMED 10-01 to be applied for stock assessments lacking standard data requirements. Such tests should be run using the examples of stocks, for which the standard data requirements are fulfilled. STECF is requested to comment on the applicability of the results obtained from the empirical indicators for scientifically sound fisheries management advice.

h) continue the formulation of the program R-scripts and to test them to evaluate MEDITS and other CPUE or abundance survey results as initialized during STECF SGMED-10-01. As a first priority, the survey evaluation should allow assessments of trends in stock specific abundance and biomass trends, also length and age based, not only for the total stock but also separately for the juvenile and adult components. As a second priority, standardization between independent time series of surveys with respective parameters of correlation, bias and precision shall be realized.
It would be advisable to carry out comparisons for consistency with outputs from other d-bases as developed at national/international levels including also the the AdriaMed Trawl Surveys Information Systems (ATrIS).

i) review and evaluate existing scientific frameworks for the elaboration of mixed fisheries management advice, and develop a framework to deliver management advice for multi-species/stocks fisheries in the Mediterranean and Black Seas. Such framework shall consider and be consistent with the management advice for fisheries of single species/stocks provided by STECF so far and provide medium term scenarios constrained by one or all species/stock specific management points to be achieved by 2015 or 2020, respectively. The framework shall be age-structured, to the extent possible, and be based on ecological data and concepts as a first step; considerations shall be given to accommodate within this framework, whenever necessary, empirical indicators. The input data required and model processes to deliver management advice for multi-species/stocks fisheries shall be described in detail.
The management advice shall consider quantitative annual effort changes and consistent catch possibilities.

The link to and incorporation of economic data and concepts shall be further elaborated as a follow up and, if possible, a first evaluation of the bio-economic consequences of the explored management scenarios for some fisheries should be provided.

The use of multiple indicators, either model based or empirical and of biological and/or economic nature, within a single management advice framework shall be considered and commented as adequate.

k) note that the last STECF expert meeting in 2011 (EWG 11-20: Assessment of Mediterranean Sea stocks - part 3), previously being planned for the period 12-16 December 2011, is deferred and will now be convened from 16-20 January 2012. The expert meeting will focus on short and medium term projections of stock size and catches as well as bio-economic modelling as successfully conducted in since 2009.

l) Any Other Business:

- evaluate the influence of sea-bottom temperature on trawl swept-area estimations.

- Improving fishing effort descriptors: modelling engine power and gear-size relations.

- Advise on the technical meaning of the "mesh size opening" concept and on the way such a mesh size is measured in relation to the diagonal and side of a mesh. Advise on the relation between "stretched mesh-size" and "mesh size opening".
Explain the meaning and correlation among different ways of expressing the twine thickness (e.g. mm; denier, etc.);

- Advise on the equivalent stretched mesh size for a knotted polyamide net of a mesh size opening of 16 mm and a thickness of 210/2 denier; provide a conversion factor between mesh size opening and stretched mesh size for such a type of net.

- Assessment of management plan 2011-2015 submitted by Malta**.**

STECF EWG 11-12 is requested to review the scientific basis for management plan(s) as required by the Mediterranean Regulation (C.R. (EC) No1967/2006), to evaluate its findings, to make appropriate comments, also with respect to the elements/measures included in the proposed management plan and to advise whether the plan contains elements that account for:

1. the biological characteristics and the state of the exploited resources,
2. the fishing pressure and if concerned fisheries are duly described and expected to exploit the main target stocks in line with their production potentials. Advise whether the plan is expected to maintain or to revert fisheries productivity to higher levels in line with MSY or proxy and in which time frame.
3. impact of fishing activities on marine environment (protected habitats and species)
4. size and/or species selectivity of the regulated fishing gears with particular attention to sizes and relative quantities of species mentioned in Annex III of the Mediterranean Regulation.

Table 1: Additional species as included in the data collection regulations.

Species common name, species scientific name FAO CODE
1. Bogue *Boops boops* BOG
2. Common dolphinfish *Coryphaena hippurus* DOL
3. Sea bass *Dicentrarchus labrax* BSS
4. Grey gurnard *Eutrigla gurnardus* GUG
5. Black-bellied angler *Lophius budegassa* ANK
6. Anglerfish *Lophius piscatorius* MON
7. Blue whiting *Micromesistius poutassou* WHB
8. Grey mullets (*Mugilidae*) Mugilidae MUL
9. Common Pandora *Pagellus erythrinus* PAC
10. Caramote prawn *Penaeus kerathurus* TGS
11. Mackerel *Scomber spp.* MAZ
12. Common sole *Solea solea* (=*Solea vulgaris*) SOL
13. Gilthead seabream *Sparus aurata* SBG
14. Spottail mantis squillids *Squilla mantis* MTS
15. Mediterranean horse mackerel *Trachurus mediterraneus* HMM

16. Horse mackerel *Trachurus trachurus* HOM
17. Tub gurnard *Trigla lucerna* (= *Chelidonichthys lucerna*) GUU

Table 2: Additional species not included in the data collection regulations.

Species common name, species scientific name FAO CODE
1. Sargo breams *Diplodus spp.* SRG
2. Axillary seabream *Pagellus acarne* SBA
3. Blackspot seabream *Pagellus bogaraveo* SBR
4. Greater forkbeard *Phycis blennoides* GFB
5. Poor cod *Trisopterus minutus* POD

4.2 Participants

The full list of participants at EWG 11-12 is presented in Annex I to this report.

5 ToR A-E UPDATE AND ASSESS HISTORIC AND RECENT STOCK PARAMETERS (SUMMARY SHEETS)

The following section of the present report does provide short stock specific assessments in the format of summary sheets. Such summary sheets are only provided in cases when the analyses resulted in an analytical assessment of exploitation rate. Unlike earlier years, the assessments are presented in geographic order by GSA, and not any longer by species. The format of the summary sheet has been agreed by the experts in 2008. Detailed versions of the assessments of stocks and fisheries are provided in the following section 6 of the report.

5.1 Summary sheet of European hake (*Merluccius merluccius*) in GSA 01

Species common name:	European hake
Species scientific name	*Merluccius merluccius*
Geographical Sub-area(s) GSA(s):	GSA 01

Most recent state of the stock

- State of the adult abundance and biomass:

Stock assessment has been computed by XSA method using data from 2003 to 2010. Although SSB fluctuated without a general trend and increased in 2009 and 2010. In the absence of a precautionary reference level the STECF EWG 11-12 is unable to fully evaluate the state of the stock size.

- State of the juvenile (recruits):

Over the period 2003-2010 the recruitment displayed noticeable inter-annual variations, with no apparent trend.

- State of exploitation:

The exploitation is mainly based on age classes 0 and 1, with age 1 as the smallest age fully recruited. EWG 11-12 proposes $F_{0.1} \leq 0.21$ as limit management reference point (F_{MSY} proxy) consistent with high long term yields. By comparing $F_{0.1}$ against F_{curr}, taking as reference $Fbar_{02}$ over 2003-2010 and $Fbar_{12}$ over 2003-2010, EWG 11-12 concludes that the stock is subject to overfishing. Results were the following: taking as reference $Fbar_{0\text{-}2}$ over 2003-2010, $F_{curr} = 0.98$, $F_{0.1} = 0.16$; and taking as reference $Fbar_{1\text{-}2}$ over 2003-2010, $F_{curr} = 1.37$, $F_{0.1} = 0.22$.

- Source of data and methods:

The state of exploitation was assessed for the period 2003-2010 applying the Extended Survivor Analysis (XSA) method calibrated with fishery independent survey abundance indices (MEDITS). This is the first time this method is used in the assessment of hake in GSA01. In addition, a yield-per-recruit (Y/R) analysis was carried out. Both methods were performed from the size composition of trawl landings, transforming length data to ages by slicing (L2AGE program) using a VBF functions (i.e. growth parameters).

Input data were taken from DCF. Natural mortality (vector) was estimated using PROBIOM. Discards are believed neglible and not included in the assessment.

Outlook and management advice

The continued low abundance of adult fish in the surveyed population and landings indicate a very high exploitation pattern far in excess of those achieving high yields and low risk of stock collapse.

EWG 11-12 recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed $F_{0.1}$ level, in order to avoid future loss in stock productivity and landings. This target should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up meeting STECF EWG 11-20 (16-20 January 2012) depending on data availability.

Fisheries

European Hake is the demersal species with the important landings in the GSA 01. The species is targeted by bottom trawl, gillnet, trammel net and longline. Discards in weight are very low or nil. Over the period 2003-2010 annual landings oscillated between around 300 and 600 tonnes (by far, most of the landings are obtained by bottom trawl).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (mean) adopted as proxy for Fmsy	≤ 0.21
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

This is the first assessment of hake in GSA01 using XSA. Thus, results of this analysis are not straightforward comparable to those of the previous assessment conducted during EWG11-05. Based on pseudocohort analysis (VIT), using 2008 and 2009 data, a reference point for this stock was: $F_{0.1}$ (mean) ≤ 0.21. The detailed assessment of European hake in GSA 01 can be found in section 6.

5.2 Summary sheet of red mullet (*Mullus barbatus*) in GSA 01

Species common name:	Red mullet
Species scientific name	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 01

Most recent state of the stock

- State of the adult abundance and biomass:

Stock assessment has been computed by XSA analysis using DCF data of landings at age from OTB and GTR data (2003-2010). SSB is indicated to have increase over the time trend. Medits survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. Since no precautionary level for the stock size of red mullet in GSA01 was proposed, EWG 11-12 cannot evaluate the stock status in relation to the precautionary approach.

- State of the juvenile (recruits):

There is an increasing trend in the number of recruits since 2003 to 2010. No base line for comparison of the current values against historic recruitment is available.

- State of exploitation:

EWG 11-12 proposed $F_{0.1}$=0.30 as limit reference point consistent with high long term yield (F_{msy} proxy). Based on the assessment results (F_{curr}=1.79), EWG 11-12 assessed the status of the stock of red mullet in GSA01 as being subject to overfishing.

- Source of data and methods:

XSA analysis was computed on DCF data of commercial landings (2003-2010), calibrated with fishery independent survey abundance indices (MEDITS). Discards are believed to be low and neglible. This is the first time this method is used in the assessment of red mullet in GSA 01. In addition, a yield per recruit (Y/R) analysis was carried out. Both methods were performed from the size composition of OTB and GTR landings, transforming length data to ages by slicing (L2AGE program) using a VBF functions (i.e. growth parameters).
Natural mortality vector was estimated using PROBIOM.

Outlook and management advice

EWG 11-12 recommends the relevant fleets effort to be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches and effort consistent with F_{msy} should be estimated.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

No updated description is provided. Landings data were reported to EWG11-12 through the Data collection regulation (OTB and GTR). Otter trawl landings represent around the 87% of the catches. Total landings increased from 95 t in 2002 to 225 t in 2009 and decreased in 2010 to 200 t. Discards are considered negligible and range at or below one ton.

Annual landings (in tons) by fishing technique as reported to EWG11-12 through the DCR data call.
GTR: trammel net; OTB: bottom otter trawl

	2002	2003	2004	2005	2006	2007	2008	2009	2010
GTR	14	20	15	18	19	18	17	23	14
OTB	81	119	113	94	105	130	136	202	186

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-05

$F_{0.1}$ (mean) Fmsy proxy	≤ 0.30
F_{max} (age range)=	0.54
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

This is the first assessment of red mullet in GSA01 using XSA. Thus, results of this analysis are not straightforward comparable to those of the previous assessment conducted during EWG 11-05. Based on pseudocohort analysis (VIT), using 2008 and 2009 data, a reference point for this stock was: $F_{0.1}$ (mean) ≤ 0.52. The detailed assessment of red mullet in GSA 01 can be found in section 6 of this report.

5.3 Summary sheet of European hake (*Merluccius merluccius*) in GSA 06

Species common name:	European hake
Species scientific name	*Merluccius merluccius*
Geographical Sub-area(s) GSA(s):	GSA 06

Most recent state of the stock

- State of the adult abundance and biomass:

SSB is indicated to have increased since 2005. STECF EWG 11-12 considers its advice provided in 2009 regarding precautionary reference points of stock size as invalid given the recent data revisions. In the absence of a proposed precautionary reference point the EWG 11-12 is unable to fully evalutate the status of the stock size.

- State of the juvenile (recruits):

Recruitment varied at a reduced level since 2005.

- State of exploitation:

Given the data revisions STECF EWG 11-12 revises its limit reference point Fmsy proxy based on F0.1 estimation consistent with high long term yield and low risk of fisheries collapse to Fmsy≤0.11. Considering the estimate of $Fbar_{0\text{-}3}$=1.3 in 2010 the EWG 11-12 concluded that the stock is subject to overexploitation. The size composition of landings indicates that the exploitation is based on the very young age classes, mainly 0, 1 and 2 years old. The continued low abundance of adult fish in the surveyed population and landings indicate a very high exploitation pattern far in excess of those achieving high yields and low risk of fisheries collapse.

- Source of data and methods:

The state of exploitation was assessed for the period 2002-2010 applying the Extended Survivor Analysis (XSA) method calibrated with fishery independent survey abundance indices (MEDITS). In addition, a yield-per-recruit (Y/R) analysis was carried out. Both methods were performed from the size composition of trawl landings, transforming length data to ages by slicing (L2AGE program) using a VBF functions (i.e. growth parameters).

Input data were taken from DCF data. No sizes composition for longliners was provided. The growth curve used was that of fast growth hypothesis. The growth parameters are: L_{inf}: 106.0, K=0.20, t_o: -0.0028. Natural mortality values (vector) were computed with PROBIOM. The set of parameters used in the 2011 assessment is different from that used in the previous analysis of this stock (SGMED09-02), which corresponded to a slow growth patterns of the species. Discard estimates may be significant but were not considered in the assessment.

Outlook and management advice

EWG 11-12 recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects.

The increase of the gillnet and long lining effort over the period 2002-2010 may decline the spawning biomass even further considering that a major part of the spawners are caught by these passive fishing gears. Thus, EWG 11-12 recommends a reduction in trawling fishing effort at least proportional to the decline necessary to reach F_{msy}, along with a reduction of gillnet and long lining effort, in the context of a multi-annual management plan taking into account the multi-species landings of the trawl.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up meeting STECF EWG 11-20 (16-20 January 2012) depending on data availability.

Fisheries

Hake (*Merluccius merluccius*) is one of the most important target species for the trawl fisheries carried out by around 600 vessels in the Northern Spain (GSA 06) with an average of 47 TRB, 58 GT and 297 HP. It is also targeted by longliners and gillnetters. In the last years (2002-2010), the total annual landings of this species, which are mainly composed by juveniles living on the continental shelf, were around 4.000 tons in the whole GSA.

Annual landings (in tons) in GSA 06 (1997-2010).

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Hake Landings GSA6	3975	3105	3854	4873	5275	4048	4161	3760	4036	4627	3396	3985	5082	3278

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (0-3)	≤ 0.11 (sexes combined)
F_{max} (age range)=	0.18
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock) ≥ 4,000 t	
B_{pa} (B_{lim}, spawning stock) ≥ 2,200 t	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

There are large differences when evaluating the relative difference between the hake GSA 06 landings data submitted in 2011 versus the landings submitted in 2010 for the period 2002-2009. There are also problems related to data formats (length class intervals and units). No data were available on the discards sizes or age distributions as well as no sizes information from longline landings. Abundance and biomass indices derived from Medits data in 1998 should be checked (values are very low). The detailed assessment of European hake in GSA 06 can be found in section 6.

5.4 Summary sheet of red mullet (*Mullus barbatus*) in GSA 06

Species common name:	Red mullet
Species scientific name	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 06

Most recent state of the stock

- State of the adult abundance and biomass:

The SSB in 2010 is below the long term average and a short term recovery seems unlikely if we consider that recruitment in 2010 is at the lowest observed level (taking into account the entire time series). In the absence of a precautionary reference point, STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

- State of the juvenile (recruits):

The recruitment in 2010 showed the lowest value of the time series after a continued decrease since the mid 2000s.

- State of exploitation:

EWG 11-12 proposes a new estimation of $F_{0.1}$=0.38 as Fmsy proxy and limit reference point consistent with high long term yields and low risk of fisheries collapses. With the F_{curr} being estimated at 1.90, EWG 11-12 concludes that the stock is being subject to overfishing.

- Source of data and methods:

Data used in the assessment were collected through 2011 DCF data call and provided during the STECF EWG 11-12 meeting. However, for total annual landings we used data from the 2010 DCF, which derived from fish market statistics provided by the regional governments, because they were considered more reliable than the total landings provided in the 2011 DCF, which derived from logbooks. Discards are believed neglible.

The state of exploitation was assessed by means of a XSA analysis (2002-2010), tuned abundance indices from trawl survey (MEDITS). In addition, a yield-per-recruit (Y/R) analysis was applied to the data to estimate $F_{0.1}$ and F_{max}. Input data were the age composition of trawl catches provided by the DCF. Annual length distributions of landings in 2010 were transformed to ages using L2Age4.exe (estimated using the numbers by size and the growth parameters). The tuning parameters (MEDITS) were calculated by transforming the MEDITS length distributions to ages with the L2AGE software using a VBF functions (i.e. growth parameters).

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Outlook and management advice

The stock is subject to overfishing by trawlers (which account for 98% of the total red mullet catch) and thus EWG 11-12 recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings, particularly during the recruitment season (fourth quarter, when landings are at the maximum) and in the context of a multi-annual management plan taking into account the multi-species landings of the trawl.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

According to the analysis carried out with data submitted in 2011, trawl accounts for the majority (98%) of the total landings of red mullet. The remaining 2% is taken by the gillnetters (small-scale or artisanal fisheries). The largest proportion of the total red mullet catch is taken by trawlers in the fourth quarter, coinciding with the recruitment of this species to the fishing grounds. The exploitation of small individuals (recruitment fishery) by trawlers in autumn occurs since decades (stated already by Demestre et al, 1997; Sánchez et al., 1995; Martín et al., 1999; Lloret and Lleonart, 2002).

Landings of *M. barbatus* increased continuously from the earliest 1970's until 1998. From this year until 2006 a general decreasing trend with some fluctuations is observed.

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA 6 Landings (t)	1159	1004	958	1027	1437	1232	1056	1011	972

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (1-3) Fmsy proxy, male and females combined, Y/R analysis	≤0.38
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

Data on landings by length class or age group for gillnets were only reported for 2009-2010. There are large differences when evaluating the relative difference between the red mullet GSA 06 landings data submitted in 2011 versus the landings submitted in 2010 for the period 2002-2009 (differences can be up to 77%).

The 2010 length and age distribution should be taken with caution because there was a change in the sampling methodology in GSA 06. The detailed assessment of red mullet in GSA 06 can be found in section 6 of this report.

5.5 Summary sheet of pink shrimp (*Parapenaeus longirostris*) in GSA 06

Species common name:	Deepwater pink shrimp
Species scientific name	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 06

Most recent state of the stock

- State of the adult abundance and biomass:

Since 2001, SSB is indicated vary without a clear trend. In 2010, the SSB appears to have increased. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the stock size status.

- State of the juvenile (recruits):

Since 2001 recruits (aged 0 individuals) were estimated to vary without a clear trend.

- State of exploitation:

The STECF EWG 11-12 recommends F0.1 = 0.25 (Fmsy proxy) as limit management reference point consistent with high long term yields and low risk of fisheries colloapse.
Fishing mortality over ages 0-5 displays a high variation with an average value of 1.0. STECF EWG 11-12 concludes that the resource is subject to overexploitation.
The size composition of landings indicates that the exploitation is based on the very young age classes, mainly 1 and 2 years old. The continued low abundance of adult fish in the population and landings indicate a very high exploitation pattern far in excess of those achieving high yields and low risk of fisheries collapse.

- Source of data and methods:

The state of exploitation was assessed for the period 2001-2010 for the GFCM geographical sub-area Northern Spain (GSA-06). Discards may be substantial but were not considered due to lack of information. A VPA tuned with CPUE from commercial fleet and abundance indices from MEDITS trawl surveys, was carried out applying the Extended Survivor Analysis (XSA) method over the period 2001-2010. This method was performed from size composition of trawl catches (obtained from on board and on port monthly sampling) and official landings transforming length data to age data by slicing with the L2AGE software using a VBF functions (i.e. growth parameters). Available CPUE data series, both of commercial fisheries, from Santa Pola fleet, and scientific survey MEDITS were evaluated but only the MEDITS survey is used. Growth parameters used here were as those from Garcia-Rodriguez et al. (2009). Maturity ogive was taken from García Rodriguez et al. (2009). Natural mortality values (vector) were computed using PROBIOM.

Outlook and management advice

EWG 11-12 recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings and a recovery plan to be established for this stock which takes into account the mixed species nature of the fishery.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG meeting (16-20 January 2012) depending on data availability.

Fisheries

Deep-water pink shrimp (*Parapenaeus longirostris*) is one of the most important crustacean species for the trawl fisheries developed along the GFCM geographical sub-area Northern Spain (GSA 06). This resource is an important component of commercial landings in some ports of the Mediterranean Northern Spain and occasionally target species of the trawl fleet, composed by around 600 vessels, and especially by 260 vessels which operate on the upper slope. During de period 2005-2010 landings stabilized to an average of 115 tons.

Annual landings (in tons) in GSA 06 (2002-2010).

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Landings T	331	165	116	76	102	123	107	104	116	141

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (mean) Fmsy proxy (both sexes combined)	$\leq$0.25
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

There are large differences when evaluating the relative difference between red mullet GSA 06 landings data submitted in 2011 versus the landings submitted in 2010 for the period 2002-2009. The 2010 length and age distribution should be taken with caution because there was a change in the sampling methodology in GSA 06. The detailed assessment of pink shrimp in GSA06 can be found in the following 6.

5.6 Summary sheet of European hake (*Merluccius merluccius*) in GSA 09

Species common name:	European hake
Species scientific name	*Merluccius merluccius*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

Using F at age data and recrutiment estimates as input of aY/R analysis, SSB in 2010 was estimated to be 10-15% of the SSB at F_{msy}. In the absence of any precautionary reference point the STECF EWG 11-12 is unable to fully evaluate the stock size status.

- State of the juvenile (recruits):

Recruitment from 2005 showed a decreasing trend with a lowest value in 2010. The Medits recruitment index shows large fluctuations with any clear trend.

- State of exploitation:

The STECF EWG 11-12 proposes $F_{0.1}$=0.2 (Fmsy proxy) and limit management reference point consistent with high long term yield and low risk of fisheries collapses. Thus the stock appeared heavily overexploited in 2009-2010 and F needs a consistent reduction from the current F towards the candidate limit reference points for long term sustainability. However, considering the high productivity in terms of incoming year classes, this stock has the potential to increase in size quickly if F is reduced towards F_{msy}. The continued lack of older fish in the surveyed population indicates exploitation rates far beyond those considered consistent with high yields and low risk.

- Source of data and methods:

Data coming from MEDITS (1994-2009) trawl surveys were used to estimate relative SSB and F with Surba. Data coming from DCF (age distribution of catch for trawl and gillnet) for the period 2005-2010 were used to run the Extended Survivor Analysis (XSA), method calibrated with fishery independent data (MEDITS abundance indices for 2005-2010). Discards may be significant but are not considered in the assessment. The following parameters were used both for SURBA and XSA analyses:

Growth parameters (Von Bertalanffy)
$L\infty$ = 104 (cm, total length); k = 0.2; $t_{0=}$ 0.03
L*W: a = 0.006657; b=3.028
M vector Age_1=1.3, Age_2=0.6, Age_3=0.46, Age_4=0.41, Age_5=0.3 (ProdBiom)
q(age 1+) = 0.8, q(age 2+) = 1.0, q(age 3+)=0.7, q(age 4+)=0.7, q(age 5+)=0.7
Length at maturity (L_{50}) = 30 cm total length (sex combined)

Outlook and management advice

EWG 11-12 recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

Hake is the demersal species providing the highest landings and incomes in the GSA 09. About 60% of hake landings are due to bottom trawl vessels; the remaining fraction is caught by artisanal vessels using set nets, in particular gillnets. The trawl fleet of GSA 09 at the end of 2009 accounted for 339 vessels. The main trawl fleets of GSA 09 are present in the following continental harbours: Viareggio, Livorno, Porto Santo Stefano (Tuscany), Fiumicino, Terracina, Gaeta (Latium). The artisanal fleets, according to the 2009 data, accounted for 1,296 vessels that operate in several harbours along the continental and insular coasts. A fleet of about 50 vessels, exploits hake using gillnets. The fishing capacity of the GSA 09 has shown in these last 20 years a progressive decrease; from 1996 to 2010 the number of bottom trawlers of GSA9 decreased of about 30%. Consequently also fishing effort is presumably decreased in this period. In the last five years the total landings of hake of GSA 09 fluctuated between 1100 (2004) to about 2300 tons, with 1484 tons in 2010. Trawl landings are traditionally dominated by small sized specimens; they are basically composed by age groups 0 and 1. Gillnet fishery lands mostly age 2 -5 fish. High quantities of small size hake are routinely discarded, especially in summer and on fishing grounds located near the main nursery areas of the species. About 690 tons of hake discards were estimated in 2009, and 130 tons in 2010 for the trawl fishery in GSA 09 depending on the dimension of the annual recruitment. Due to the introduction of the EU Regulations on minimum sizes, a progressive increase of the size at which 50% of the specimens caught was discarded has been observed in the last ten years.

Landings (t) by year and major gear types, 2004-2010 as reported through DCR.

Type FT_LVL4	2004	2005	2006	2007	2008	2009	2010
GND			4.8				
GNS	249.5	551.0	592.9	580.2	348.9	409.2	567.2
GTR	346.4	284.4	404.0	131.9	61.1	54.0	57.7
LLD	1.1		56.8	0.2	2.2	4.4	
LLS	3.3	5.2	85.1	15.6	2.9	2.0	1.0
OTB	552.9	1053.9	1180.0	1025.0	914.8	853.2	834
PS	0.0		2.8			6.2	
SB-SV	1.5		0.1				
Total landing (tons)	1154.7	1894.5	2326.4	1752.8	1329.8	1329.0	1459.9

Trend in fishing effort (kW*days,) by major gear types, 2002-2010.

Type FT LVL4	2004	2005	2006	2007	2008	2009	2010
GNS	2828257	3887852	3192557	3730816	2897517	3165163	2641506
GTR	2930802	3825650	3758552	2840462	2330668	2819133	2719155
LLD	435343	795954	872471	485306	576643	326821	434722
OTB	13997398	14737375	12427695	13044590	10602617	11927325	11291098
PS	385988	455763	1128366	1117009	976131	1311059	920985

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (mean) Fmsy proxy	≤ 0.2
F_{max} (age 1-5)=	0.35
F_{msy} (age range)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	

Comments on the assessment

GRUND data prior to 1994 should be standardized and used within this assessment. The detailed assessment of hake in GSA 09 can be found in section 6 of this report.

5.7 Summary sheet of red mullet (*Mullus barbatus*) in GSA 09

Species common name:	Red mullet
Species scientific name	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

The index of stock abundance from GRUND survey shows high variability throughout the time series, but no trend is observed. The index of abundance from MEDITS surveys, that approximates a spawning stock biomass index (mostly represented by mature fish), suggests an almost steady status from 1994 to 2009 with a high interannual fluctuation. In the absence of a precautionary reference point the STECF EWG- 11-12 is unable to fully evaluate the status of the stock size.

- State of the juvenile (recruits):

Recruitment shows a slight increasing trend, especially in the most recent years.

- State of exploitation:

The EWG 11-12 proposes F_{msy} =0.47 as limit management reference point consistent with high long term yield an low risk of fisheries collapses. The stock is considered overexploited (Bcurr/B_{MSY} of about 0.6), with estimates of the current fishing mortality F_{2010} of 0.54 (derived from ASPIC) that is higher to the estimated values that were considered limit reference point obtained with the same approach. The current F estimated by Length Cohort Analysis was of 0.59 considering the fully exploited age classes. Yield per recruit analysis suggest that the size of first capture is too low (growth overfishing). An increase in yield is expected in medium term in the case a reduction of fishing effort does occur and/or more selective gears are used. EWG reccomends the fleet fishing effort to be reduced until fishing mortality is at or below the estimated F_{msy} level.

- Source of data and methods:

Data used derive from trawl surveys, with data on size composition and abundance indices, commercial landings by size/age and data on catches and directed fishing effort derived from commercial catch assessement surveys. Discards may be significant but are not considered in the assessment. A dynamic Biomass Production model (ASPIC) using both a time series from 1994 and 2010 of catch and effort of commercial vessels proceeding from two of the main ports (Viareggio and Porto Santo Stefano) and an abundance index derived from trawl surveys for the same time interval were used to estimate F_{MSY}, q for each fishery, B_{MSY}, F_{MSY}, and a value of F for each year along the time series. A cohort analysis using commercial landings demographic structure for the year 2010 was also used for deriving F estimates by year, numbers at age and other features. The value of the $F_{0.1}$ was estimated with the software YPR of the NOAA toolbox.

Outlook and management advice

EWG 11-12 recommends the relevant fleets effort to be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches and effort consistent with F_{msy} should be estimated.

Short and medium term scenarios:

Regarding stock biomass and catches an increasing trend has been observed but there is a slight decline of both in 2010.

Fisheries

The species is mainly exploited by bottom trawlers, being the catches derived from artisanal fisheries negligible. *Mullus barbatus* catch rates are much higher in late summer-autumn. About 200 trawlers and a relatively small but variable number of artisanal vessels exploit the species in the GSA 09. Annual landings, mostly proceeding from trawling, ranged from 500 to 1100 tons in the last years. (786.7 in 2010)

The species is caught as a part of a species mix that constitutes the target of the trawlers operating near shore. The main species caught in GSA 09 are *Squilla mantis, Sepia officinalis, Trigla lucerna, Merluccius merluccius, Mullus barbatus, Gobius niger. Mullus barbatus* is mainly caught in late summer-beginnings of autumn, when juveniles are highly concentrated near shore. Age of first capture is of about 7 cm. Catch is mainly composed by age 0 individuals while the older age classes are poorly represented in the catch. Catch rates increased along the analysed period and considering that no dramatic changes occurred on effort allocation nor on other aspects of fishing behaviour in the analysed years, this increase has to be attributed to an enhancement in biomass. Even if catch within the coastal 3 miles is forbidden, illegal fishing do occur considering the high economic value that small-sized individuals have in the area. There is no available information on the total catches for 2009.

Total catches (in tons) of *Mullus barbatus* by gear in GSA09 (2004-2010)

	2004	2005	2006	2007	2008	2009	2010
Nets	60.0	24.0	16.0	9.0	11.0	21.0	22.2
Trawlers	521.0	684.0	1033.0	1087.0	716.0	707.0	764.2
Longlines					0.0		
Miscelaneus	2.3		0.5				
Seines	0.0	0.1					
TOTAL	583.3	708.1	1049.5	1096.0	727.0	728.0	786.7

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (mean)	≤ 0.48 (average for age classes 0-3)
F_{max} (age range)=	1.02 (average value for all ages)
F_{msy} (age range)=	0.47 (all exploited ages)
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of red mullet in GSA 09 can be found in section 6 of this report.

5.8 Summary sheet of striped red mullet (*Mullus surmuletus*) in GSA 09

Species common name:	Striped red mullet
Species scientific name	*Mullus surmuletus*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

EWG 11-12 is unable to fully evaluate the status of the stock size as no precautionary reference point is defined. The analyses performed give a SSB estimation of 335 tons in 2009. The Medits survey indicate recent fluctuations without a clear trend in stock abundance. However, the recent estimates indicate a low stock size in 2008 and 2009.

- State of the juvenile (recruits):

Given the quality of data and results, EWG 11-12 cannot conclude on the state of recruitment. The analyses performed give an estimation of 5.8×10^6 recruits in 2009 and 6.2×10^6 in 2010.

- State of exploitation:

EWG 11-12 proposes $F_{0.1} \leq 0.31$ as limit management reference point consistent with high long term yields (F_{MSY} proxy). The F=0.71 in 2009 and F=0.56 in 2010 are above the Y/R F_{MSY} reference point, which indicates that striped red mullet in GSA 09 is subject to overfishing.

- Source of data and methods:

Data used were derived from commercial catches (landing and discard) by size and age. A cohort analysis with VIT using commercial catches for the years 2009 and 2010 separately was performed to estimate F, $F_{0.1}$, numbers at age and other stock parameters.

Outlook and management advice

EWG 11-12 recommends reducing fishing mortality towards the proposed reference point F_{MSY}. This can be achieved by reducing fishing effort of the relevant fleets. Catches and effort consistent with F_{MSY} should be estimated.

As striped red mullet is mainly caught by different gears and in mixed fisheries, the measures adopted to reduce fishing mortality require multi-annual management plans that take into account mixed-fisheries considerations to be developed and fully implemented.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012), depending on data availability.

Fisheries

The species is exploited by different types of gears. The annual landing for 2009 was due for 30% to bottom trawl (75 tons), for 31% to gillnet (76 tons) and for 39% to trammel net (96 tons). In 2010 the highest landing was due to trammel net (57%, 159 tons), while bottom trawl and gillnet contributed for 18% and 25% respectively. About 200 bottom trawlers exploit this resource all year round in the coastal area frequently using specific devices to exploit hard bottoms where the species is more abundant. Striped red mullet is caught as a part of a species mix that constitutes the target of the trawlers operating near shore. The main species caught in GSA09 are *Squilla mantis, Sepia officinalis, Trigla lucerna, Merluccius merluccius, Mullus barbatus, Zeus faber.* The length of first capture of the striped red mullet is of about 10 cm. Trawl catch is mainly composed by age 0+ and 1 individuals while the older age classes are poorly represented in the catch.

As concerns artisanal fisheries, *M. surmuletus* represents the target species in some period of the year (end of spring-summer) and it is caught by is caught by gillnet and trammel net. Part of the fleet uses a small mesh size trammel net to catch this species on rocky bottoms near the shore. The catch is mainly composed by individuals at ages 0+ and 1.

The landing showed a clear decreasing trend in the period 2005-2008, with maximum value in 2005 (404 tons) and minimum in 2008 (224 tons). A slightly increase is observed in the last two years. It is difficult to correlate this trend with the reduction in fishing effort as it is not possible to quantify the real effort exerted by the fleet on this resource. However, the LPUEs calculated on the entire fleet show considerable fluctuations with a decreasing trend for gillnet and bottom trawl; for trammel net a high peak is observed in the last year.

Total catches (in tons) of *Mullus surmuletus* by gear in GSA09 (2004-2010)

	2004	2005	2006	2007	2008	2009	2010
Otter trawl	94	143	78	60	58	78	51
Gillnet	142	139	143	188	80	76	68
Trammel net	136	122	152	74	86	96	159
Total	372	404	373	322	224	250	278

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (mean) Fmsy proxy	≤ 0.31
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of striped red mullet in GSA 09 can be found in section 6 of this report.

5.9 Summary sheet of blue and red shrimp (*Aristeus antennatus*) in GSA 09

Species common name:	Blue and red shrimp
Species scientific name	*Aristeus antennatus*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

Stock assessment has been computed using Length Cohort Analysis (VIT software) with DCF data of landings at age (2006-2010). Results obtained didn not show a clear trend in the stock size. Medits survey indices indicate a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. In the period analyzed (2006-2010) indices of biomass and abundance showed a stationary phase followed by a remarkable increase in 2010. Since no precautionary level for the stock of blue and red shrimp in GSA09 was proposed, STECF EWG 11-12 is unable to evaluate the stock status in relation to the precautionary approach.

- State of the juvenile (recruits):

Box-plot of Medits length frequency distributions have shown that in the 2008-2009 a remarkable recruitment phase seems to took place in the area. The high recruitment event of 2008 is confirmed also in the length at age distribution of the commercial landings.

- State of exploitation:

EWG 11-12 proposes F0.1≤0.32 as limit management reference point consistent with high long term yields (FMSY proxy).
According to the F estimates obtained using Length Cohort Analysis, average F all ages (0.62) was over the estimated average F0.1 values. In this case, the stock would not appear to be able to sustain the current level of fishing effort in the GSA09 and thus STECF EWG 11-12 considers the stock to be subject to overfishing.
EWG 11-12 recommends that fishing effort to be reduced until fishing mortality is below or at the proposed level Fmsy, in order to avoid future loss in stock productivity and landings.
It is important to consider that this stock could be strongly affected by environmental and ecological factors (e.g. water temperature, predation).

- Source of data and methods:

Length cohort analysis was computed on DCF data of commercial landings (2006-2010). Landings per age were obtained splitting LFD respects on the following growth parameters CL_{∞}=76.9 cm, K=0.21. Length-weight relationship coefficients were a=0.0029 and b=2.449. Natural mortality vector was estimated using PRODBIOM. Discards are believed neglible and were not considered in the assessment.

Outlook and management advice

STECF EWG 11-12 recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed F_{MSY} level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches and effort consistent with F_{MSY} should be estimated.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the next STECF EWG meeting (16-20 January 2012), depending on data availability.

Fisheries

The blue and red shrimp is one of the most valuable demersal resources for the trawling fleet operating on the muddy bottoms of the upper and middle slope up to 750-800m depth. More than 95% of GSA09 annual landings were observed in the northern part of the area and there were no discards. Annual landings depict a clear growing trend from 2007 to 2010. Nominal effort (kW*days) decreased from 2005 until 2009, reflecting an increasing in LPUE in the last 2 years.

Annual landings (in tons) by fishing technique in GSA09 (2004-2010)

COUNTRY	YEAR	GEAR	AREA	SPECIES	OTB
ITA	2006	OTB	SA 9	ARA	92.70
ITA	2007	OTB	SA 9	ARA	47.37
ITA	2008	OTB	SA 9	ARA	63.46
ITA	2009	OTB	SA 9	ARA	123.50
ITA	2010	OTB	SA 9	ARA	186.40

Fishing effort (kW*days) by fishing technique in GSA09 (2004-2010)

COUNTRY	AREA	YEAR	GEAR	NOMINAL EFFORT	GT DAYS AT SEA
ITA	SA9	2004	OTB	8321497	1440765
ITA	SA9	2005	OTB	12710127	2160331
ITA	SA9	2006	OTB	9432075	1746412
ITA	SA9	2007	OTB	8404088	1433624
ITA	SA9	2008	OTB	2792267	545085
ITA	SA9	2009	OTB	2571948	446688
ITA	SA9	2010	OTB	3603156	668052

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (mean) Fmsy proxy	≤ 0.32
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of blue and red shrimp in GSA 09 can be found in section 6 of the present report.

5.10 Summary sheet of pink shrimp (*Parapenaeus longirostris*) in GSA 09

Species common name:	Deep water pink shrimp
Species scientific name	*Parapenaeus longirostris*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

Survey index of SSB and XSA estimates showed a rapid increasing pattern since 2007 with a high peak in 2010. In the absence of a precautionary biomass reference point STECF EWG 11-12 is unable to fully evaluation the stock size status.

- <u>State of the juvenile (recruits):</u>

Recruitment is indicated to have increased over time and a strong year class was observed in 2009 (424.8 millions). Both landings and survey data confirm this positive trend. Relative indices for age 1+ from survey data indicated a general increasing trend since 1994 with three main recruitment peaks in 1999, 2005 and 2009. In 2009 recruitment at age 1 (MEDITS) was 180% of the short term average (2005-07).

- <u>State of exploitation:</u>

STECF EWG 11-12 proposes $F_{0.1}$=0.7 (Fmsy proxy) as limit management reference point consistent with high long term yield and low risk of fisheries collapse.

The F estimates by means of XSA display a decreasing trend during the investigated period (2006-2010). In the 2010, the $F_{1\text{-}3}$ is well below the estimated reference value of $F_{0.1}$=0.7. STECF EWG 11-12 considers the stock has been harvested sustainably. It is important to consider that this stock could be strongly driven by environmental and ecological factors (e.g. water temperature, predatory release effect).

- <u>Source of data and methods:</u>

Data coming from MEDITS (1994-2010) trawl surveys were used to estimate relative SSB and F with Surba. Data coming from DCF (age distribution of catch for trawl) for the period 2006-2010 were used to run the Extended Survivor Analysis (XSA) method calibrated with fishery independent data (MEDITS abundance indices for 2006-2010). Discards are believed to be neglibile and are not considered in the assessment.

Outlook and management advice

STECF EWG 11-12 recomments a sustainable fishery in 2012. The projection of stock size and catch in 2012 under status quo fishing and other management options will be accomplished by the follow up meeting during 16-20 January 2012. Such advice shall be considered when multi-annual management plan taking into account mixed-fisheries effects will be designed. Catches and effort consistent with F_{MSY} should be estimated.

<u>Short and medium term scenarios:</u>

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

The species is exploited by trawl fleet mostly on muddy bottoms from 150 to 500 m depth. Annual trawl landings increased from 161 tons in 2002 to 462 tons in 2006, decreasing to 217 tons in 2007; the peak was reached at 463 tons in 2010.

Annual landings (t) by fishing technique in GSA 09 as provided through the official DCF data call 2011.

FT_LV4	2002	2003	2004	2005	2006	2007	2008	2009	2010
OTB	133	308	367	430	462	215	253	298	463
PGP		3	8	1		2	1		
PMP	19	12							
PTS	9		1						
Total	161	323	376	431	462	217	254	298	463

Trend in fishing effort (kW*days,) by major gear types.

Type FT LVL4	2004	2005	2006	2007	2008	2009	2010
GNS	2828257	3887852	3192557	3730816	2897517	3165163	2641506
GTR	2930802	3825650	3758552	2840462	2330668	2819133	2719155
LLD	435343	795954	872471	485306	576643	326821	434722
OTB	13997398	14737375	12427695	13044590	10602617	11927325	11291098
PS	385988	455763	1128366	1117009	976131	1311059	920985

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (1-3) Fmsy proxy	$\leq$ 0.70
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of pink shrimp in GSA09 can be found in section 6.

5.11 Summary sheet of giant red shrimp (*Aristaeomorpha foliacea*) in GSA 09

Species common name:	Giant red shrimp
Species scientific name	*Aristaeomorpha foliacea*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

Stock assessment has been computed by Length Cohort Analysis (VIT software) using DCF data of landings at age (2008-2010). Results obtained did not show a clear trend in the stock size. Medits survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. However, indices of biomass and abundance showed a remarkable increase in 2010. Since no precautionary level for the stock of giant red shrimp in GSA09 was proposed, EWG 11-12 is unable to fully evaluate the stock status in relation to the precautionary approach.

- <u>State of the juvenile (recruits):</u>

2010 Medits indices indicate a high recruitment impulse.

- <u>State of exploitation:</u>

EWG 11-12 proposes F0.1≤0.50 as limit management reference point consistent with high long term yields (FMSY proxy).
According to the F estimates obtained using Length Cohort Analysis, the estimated F in 2010 amounts to F=1.05. STECF EWG 11-12 classifies the stock as being subject to overfishing. EWG 11-12 recommends that fishing effort should be reduced until fishing mortality is below or at the proposed level Fmsy, in order to avoid future loss in stock productivity and landings.
It is important to consider that this stock could be strongly affected by environmental and ecological factors (e.g. water temperature, predation) which may alter the conclusion regarding its exploitation status.

- <u>Source of data and methods:</u>

Length cohort analysis was computed on DCF data of commercial landings (2008-2010). Landings per age were obtained splitting LFD respects on the following growth parameters. Natural mortality vector was estimated using PRODBIOM. Discards are believed negligible and are not considered in the assessment

Outlook and management advice

EWG 11-12 recommends the relevant fleets' effort to be reduced until fishing mortality is below or at the proposed level F_{MSY}, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches and effort consistent with F_{MSY} should be estimated.

<u>Short and medium term scenarios:</u>

Short and medium term predictions of stock biomass and catches will be accomplished during the next STECF EWG meeting 11-20 (16-20 January 2012), depending on data availability.

Fisheries

The blue and red shrimp is one of the most valuable demersal resources for the trawling fleet in GSA09. More than 95% of GSA09 annual landings were observed in the northern part of the area and there were no discards. Annual landings depict a clear growing trend from 2008 to 2010. Nominal effort (kW*days) decreased remarkably from 2007 onwards.

Annual landings (t) by fishing technique in GSA09 (2006-2010)

COUNTRY	YEAR	GEAR	AREA	SPECIES	LANDINGS
ITA	2006	OTB	SA 9	ARS	62.61
ITA	2007	OTB	SA 9	ARS	36.65
ITA	2008	OTB	SA 9	ARS	33.13
ITA	2009	OTB	SA 9	ARS	34.29
ITA	2010	OTB	SA 9	ARS	54.55

Fishing effort by fishing technique in GSA09 (2006-2010)

COUNTRY	AREA	YEAR	GEAR	NOMINAL EFFORT	GT DAYS AT SEA
ITA	SA9	2006	OTB	9432075	1746412
ITA	SA9	2007	OTB	8404088	1433624
ITA	SA9	2008	OTB	2792267	545085
ITA	SA9	2009	OTB	2571948	446688
ITA	SA9	2010	OTB	3603156	668052

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (mean) Fmsy proxy	≤ 0.50
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of giant red shrimp in GSA 09 can be found in section 6.

5.12 Summary sheet of spottail mantis shrimp (*Squilla mantis*) in GSA 09

Species common name:	Spottail mantis shrimp
Species scientific name	*Squilla mantis*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- <u>State of the adult abundance and biomass:</u>

EWG 11-12 is unable to fully evaluate the status of the stock size as no precautionary reference point is defined. The analyses performed give a SSB estimation of 368 tons in 2009 and 430 tons in 2010. The Medits survey indicate recent fluctuations without a clear trend in stock abundance.

- <u>State of the juvenile (recruits):</u>

Given the quality of data and results, EWG 11-12 is unable to conclude on the state of recruitment. The analyses performed give an estimation of of $43x10^6$ and $45x10^6$ recruits in 2009 and 2010 respectively.

- <u>State of exploitation:</u>

EWG 11-12 proposes $F_{0.1} \leq 0.54$ as limit management reference point consistent with high long term yields (F_{MSY} proxy). The current F=1.30 estimated for 2009 and 1.24 for 2010 are above the Y/R $F_{0.1}$ reference point (0.54), which indicates that mantis shrimp in GSA 09 is subject to overexploitation.

- <u>Source of data and methods:</u>

Data used derive from commercial catches (landing and discard) by size and age. A cohort analysis was performed with VIT using commercial catches for the year 2009 and to estimate F, the value of the $F_{0.1}$, the numbers at age and other stock parameters.

Outlook and management advice

EWG 11-12 recommends to reduce fishing mortality towards the proposed reference point F_{MSY} in order to avoid future losses in stock productivity and landings. This should be achieved by reducing fishing effort of the relevant fleets by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches and effort consistent with F_{MSY} should be estimated. Spottail mantis shrimp is a by-catch species in the mixed trawl fishery carried out in GSA 09.

<u>Short and medium term scenarios:</u>

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

Although the species is exploited by different types of gears, the majority of the landings come from trawling. The annual landings for 2009 were due for 95% to bottom trawl (381 tons), for 2.25% to Gillnet (9 tons) and for 2.25% to trammel net (9 tons). Discards represented in 2009 more than the 20% of the trawling total catch (86 tons), and more than the 10% in 2010 (49 tons). About 200 bottom trawlers operate in the area but it is not possible to quantify the fraction of this part of the fleet that exploit Spottail mantis shrimp in the coastal area. Spottail mantis shrimp is a coastal species, which is caught as a part of a species mix that constitutes the target of the trawlers operating near shore. The main species caught in GSA09 are *Sepia officinalis, Trigla lucerna, Merluccius merluccius, Mullus barbatus, O. vulgaris.* Trawl catch is mainly composed by age 1 and 2 individuals while the older age classes are poorly represented in the catch. For artisanal fisheries, *S. mantis* is a by-catch of gillnets and trammel nets targeting other species in the coastal area.

The total landings showed a decreasing trend in the period 2004-2010, with a maximum value in 2005 (590 tons) and minimum in 2008 (394 tons). The species is mainly landed by the trawl fleet fishing on the continental shelf and on the upper part of the continental slope. A fluctuating trend in the landing of OTB is observed, with lower values in the last two years. This trend seems to be mainly due to the reduction in fishing effort observed for this type of gear, while the LPUEs remained quite constant during the period analysed. The decreasing trend in the landings is more evident for artisanal gears. In 2010, the landings of gillnets and trammel nets were 14 tons, representing only the 4% of the total landings of the species. The LPUEs for these two gears shown a significant reduction, particularly in the case of gillnets.

Total catches (in tons) of *Squilla mantis* by gear in GSA09 (2004-2010)

	2004	2005	2006	2007	2008	2009	2010
Otter trawl	449	436	356	432	354	381	372
Gillnet	98	132	96	51	34	9	12
Trammel net	28	22	26	9	6	9	2
Total	575	590	478	492	394	399	386
Discard						86	49

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (mean) Fmsy proxy	≤ 0.54
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

This is the first assessment for the species in GSA 09 undertaken with the best available information. Further analysis including more years will be necessary to confirm the results obtained for 2009 and 2010. The detailed assessment of spottail mantis shrimp in GSA09 can be found in section 6.

5.13 Summary sheet of Norway lobster (*Nephrops norvegicus*) in GSA 09

Species common name:	Norway lobster
Species scientific name	*Nephrops norvegicus* (L., 1758)
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

Relative spawning stock biomass (SSB) indices derived from MEDITS (1994-2010) showed fluctuations without a particular trend in the spawning stock biomass (SSB). However, while both indices of abundance and biomass in 2009 showed a peak, the 2010 data showed a sharp decrease. The STECF EWG 11-12 cannot fully evaluate the state of the SSB due to a lack of precautionary management reference points.

- State of the juvenile (recruits):

Given the quality of data and results, EWG 11-12 is unable to conclude on the state of recruitment. Juveniles (0+ group) are not completely recruited by the trawl gear during MEDITS and they are also scarce in the commercial catches.

- State of exploitation:

The STECF EWG 11-02 proposes the estimated F0.1=0.21 as limit management reference point for sustainable exploitation consistent with high long term yield (FMSY proxy). Recent values of F3-6 indicate that the stock is subject to overfishing.

- Source of data and methods:

Data coming from MEDITS (1994-2010) trawl survey were used to estimate relative SSB and F using SURBA. DCF data (size distribution of trawl landings 2006-2010) were used to estimate F at age, absolute abundance at age with VIT (LCA analysis). Discards are believed negligible and are not considered in the assessment.

Outlook and management advice

STECF EWG 11-12 recommends the fisheries effort to be reduced until fishing mortality is below or at the proposed $F_{0.1}$ level, in order to avoid future loss in stock productivity and landings. This should be achieved by reducing fishing effort of the relevant fleets by means of a multi-annual management plan taking into account mixed-fisheries effects. Catches consistent with the effort reductions should be estimated.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

Norway lobster is one of the most important commercial species in the GSA as total annual landing value. All the landing is due to bottom trawl vessels exploiting slope muddy bottoms mainly between 300 and 500 m depth. Catch of vessels targeting Norway lobster is composed of a mix of both commercial (hake, deep-sea pink shrimp, horned octopus (*Eledone cirrhosa*), squids (*Todaropsis eblanae*)), and non-commercial species. The trawl fleet of GSA 09 at the end of 2007 accounted for 360 trawlers. To date about 80-100 trawlers are involved in this fishery. In the last five years the total landings of Norway lobster of GSA 09 fluctuated between 248 (2005) to 228 tons (2008). The catch is mainly composed by adult individuals over the size-at-maturity while discarding of specimens under MLS (20 mm CL) is negligible.

Landings (t) by year and major gear types, 2004-2010 as reported through DCF.

SPECIES	AREA	COUNTRY	FT_LVL4	FT_LVL5	2004	2005	2006	2007	2008	2009	2010
NEP	9	ITA			5	2	1				
NEP	9	ITA	FPO	DEMSP							
NEP	9	ITA	GNS	DEMSP	0	0	0				0
NEP	9	ITA	GNS	SLPF							
NEP	9	ITA	GTR	DEMSP		0				0	0
NEP	9	ITA	LLD	LPF	0	0					
NEP	9	ITA	OTB	DEMSP	76	14	18	45	143	159	82
NEP	9	ITA	OTB	DWSP					1		3
NEP	9	ITA	OTB	MDDWSP	193	273	229	215	84	91	77
NEP	9	ITA	PS	SPF	0						
Total					274	289	248	260	228	250	162

Trend in fishing effort (kW*days) by major gear types, 2004-2010.

Type FT - LVL4	2004	2005	2006	2007	2008	2009	2010
GNS	3758318	3902723	3260681	3755597	3054945	3216541	2641506
GTR	3281736	3814641	3861674	2760530	2403569	2948897	2719155
LLD	510386	821542	927993	507078	585762	358051	434722
OTB	14824084	14700599	12404787	12780491	11149391	12107652	11291098
PS	1424338	1426304	1146586	1116579	1017985	1283965	920985

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (age 2-7) Fmsy proxy	≤ 0.21
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

F_{msy} (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

GRUND data prior to 1994 should be standardized and used within this assessment. MEDITS survey data does not allow a reliable estimation of length-at-maturity because the survey period (late spring-early summer) does not cover the spawning season (autumn-winter). Even though other factors can affect the stock dynamics, recent decrease in SSB and recruitment seems correlated with fishing mortality.

The detailed assessment of Norway lobster in GSA 09 can be found in section 6 of this report.

5.14 Summary sheet of common Pandora (*Pagellus erythinus*) in GSA 09

Species common name:	Common pandora
Species scientific name	*Pagellus erythinus*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

The index of stock abundance from surveys shows high variability throughout the time series, but no trend is observed. The index of abundance from MEDITS, indicates a steady situation in numbers but an increase in weight, suggesting an enhancement in the numbers of bigger individuals. This is consistent with which regards the evolution of the mean size in the population. In the absence of a precautionary reference point, STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

- State of the juvenile (recruits):

Recruitment is variable but without any clear trend.

- State of exploitation:

STECF EWG 11-12 propses $F_{0.1}$=0.48 as limit reference point (Fmsy proxy) consistent with high long term yields and low risk of fisheries collapse. The current fishing mortality was estimated as F=0.63 from LCA and exeeds this reference level. The STECF EWG classifies the stock status as being subject to overfishing. EWG 11-12 recommends that fishing effort should be reduced until fishing mortality is below or at the proposed level Fmsy, in order to avoid future loss in stock productivity and landings.

- Source of data and methods:

In relation to historic values, it is observed a steady status of the abundance of the species as demostrated by commercial LPUEs in the landings in the main ports of the area and from trawl surveys abundance indices. Available data allows the performance of an assessment of the stock status but the lack of long enough time series does not allow the use of the more robust analytical approaches. Yield per recruit analysis allowed the estimation of a set of reference points ($F_{0.1}$, F_{max}, $F_{40\%MSP}$). An estimate of M of 0.27 was used for Y/R computations and for deriving F_{curr}. Growth parameters used were L_{∞}=54.3, K=0.118, t_o=-1.12, L/W a=0.0274 and b=2.9556. Discards are believed negligible and are not considered in the assessment. Recreational fishing removes a non quantified amount of individuals of *Pagellus*, but the impact of such activity is unknown.

Outlook and management advice

EWG 11-12 recommends reducing fishing mortality towards the proposed reference point F_{MSY}. This can be done by reducing fishing effort of the relevant fleets. Catches and effort consistent with F_{MSY} should be estimated.

Short and medium term scenarios:

No predictions were conducted during EWG 11-12.

Fisheries

The species is mainly caught as a part of a species mix that constitutes the target of the trawlers operating near shore. A small fraction of the catches proceed from artisanal fisheries. The main commercial species in this bottom multi-species trawl fishery in GSA 09 are *Squilla mantis, Sepia officinalis, Trigla lucerna, Merluccius merluccius, Mullus barbatus, Gobius niger.* Fishing effort have shown a moderate decling in the analyzed period 1994-2010.

The species is mainly caught in late summer-beginnings of autumn. The size of full capture is about 8 cm. Catch is mainly composed by age 0 and 1 individuals while the older age classes are poorly represented in the trawlers catch. Catch rates remained almost stable along the analysed period. No dramatic changes occurred on effort allocation nor on other aspects of fishing behaviour in the analysed years. Even if catch within the coastal 3 miles stripe is forbidden, illegal fishing doES occur producing an unknown amount of fishing mortality on juveniles of the species. The main concentrations of older individuals are positioned at higher depths than juveniles and over relatively hard bottoms and not trawlable areas.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (mean 1-6) Fmsy proxy	≤ 0.48
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of common Pandora in GSA 09 can be found in section 6 of this report.

5.15 Summary sheet of blackmouth catshark (*Galeus melastomus*) in GSA 09

Species common name:	Blackmouth catshark
Species scientific name	*Galeus melastomus*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

The index of stock abundance derived from MEDITS varies without a clear trend. The status of the assessment and data does not allow any conclusions. In the absence of a precautionary reference point, STECF EWG 11-12 is unable to fully evaluate the stock size status.

- State of the juvenile (recruits):

The status of the assessment and data does not allow any conclusions.

- State of exploitation:

The STECF EWG-11-12 proposes $F_{0.1}$=0.13 (Fmsy proxy) as limit reference point consistent with high long term yield and low risk of fisheries collapse. Sonsidering the 2010 estimate of fishing mortality rate of F=0.35 the STECF EWG classifies the stock status as being subject to overfishing.

The size of first capture is too low (growth overfishing) and an increase in yield and a more safe situation for the stock as regards the possibility of self-renewal can be expected in the case a reduction of fishing effort do occur and/or more selective gears are used. Therefore, EWG raccomends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

- Source of data and methods:

The mean *F* was estimated by means of a LCA as the mean (weighted by numbers) from age classes 1 to 6. Discards are considered in the assessment. The analyses were performed using the information of abundance and size frequencies derived from trawl surveys, size structure of commercial landings (year 2009) and data of landed and discarded fractions from data collected by observers on board.

Outlook and management advice

EWG 11-12 recommends reducing fishing mortality towards the proposed reference point F_{MSY}. This can be done by reducing fishing effort of the relevant fleets.

As blackmouth catshark is mainly caught by different gears and in mixed fisheries, the measures adopted to reduce fishing mortality require multi-annual management plans being developed and fully implemented that take into account mixed-fisheries considerations.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

The blackmouth catshark *Galeus melastomus* is a deep sea species, mainly distributed in the depth range 200-1000m. The species has a rather low commercial value. Blackmouth catshark is exclusively caught with bottom trawl nets, mainly as a by-catch of the Norway lobster fishery, by vessels operating within the 250-500m depth range and in red shrimps fisheries in deeper waters (up to 800m). Official landings in 2009 did not exceed 10 tons. Only relatively big-sized individuals are landed. Other species caught in the same fishery are *Phycis blennoides, Micromesistius potassou, Lepidopus caudatus, Trachurus trachurus, Conger conger, Macrouridae, Etmopterus spinax, Gadiculus argenteus* and *Parapenaeus longirostris.*

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-05

$F_{0.1}$ (1-6) Fmsy proxy	≤ 0.13
F_{max} (1-6)=	= 0.18
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of blackmouth catshark in GSA 09 can be found in section 6 of this report.

5.16 Summary sheet of anchovy (*Engraulis encrasicolus*) in GSA 09

Species common name:	Anchovy
Species scientific name	*Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s):	GSA 09

Most recent state of the stock

- State of the adult abundance and biomass:

In the absence of proposed or agreed precautionary management reference points EWG-11-12 is unable to fully evaluate the state of biomass. The analyses carried out on the data referred to the period 2006-2010 gave SSB estimations ranging from 1022 to 1461 tons for the period 2007-2010, with a peak in 2006 (2154 tons). Both landings and survey indices indicate the stock being at low level recently (2004-2010).

- State of the juvenile (recruits):

The analyses carried out on the data referred to the period 2006-2010 do not allow obtaining information on the state of recruitment.

- State of exploitation:

EWG 11-12 proposed $E \leq 0.4$ as limit management reference point consistent with high long term yields. The current exploitation rates estimated for the five investigated years are higher than the reference point suggested by EWG 11-12 ($E = 0.4$). Applying the exploitation rate as a reference point, this stock is considered as overexploited and F needs a consistent reduction from the current value towards the candidate reference points to achieve long term sustainability.

- Source of data and methods:

Length cohort analysis was computed on DCF data of commercial landings (2006-2010). Landings per age were obtained splitting LFD using the following growth parameters CL_∞=76.9 cm, K=0.21. Length-weight relationship coefficients were a=0.0029 and b=2.449. Natural mortality vector was estimated using PRODBIOM. Assessment was performed using an LCA (VIT software, Lleonart and Salat 1997) on an annual pseudo-cohort. Data coming from DCF provided at EWG 11-12 included, for GSA 09, information on anchovy landings and the respective purse seine size/age structure for the years 2006-2010. The size distribution for purse seine has been expanded also to the landing of other gears as information on demographic structure is available for other gears. LCA was performed using VIT software on 2009 and 2010 data.

Outlook and management advice

STECF EWG 11-12 recommends the exploitation rate to be reduced to below or at the proposed level, in order to avoid future loss in stock productivity and landings. Catches consistent with the reductions in exploitation rate should be estimated. EWG-11-12 notes that continued effort management of fisheries targeting stocks of small pelagics implies a high risk due to their schooling behavior and the multi-species character of their fisheries (changing target species as available and appropriate). EWG-11-12 rather recommends the consideration of landing restrictions as a more effective management tool for small pelagics. EWG-11-12 recommends a multi-annual management plan being implemented taking into account mixed-fisheries effects, in particular the technical relation with sardine fisheries.

The results obtained from the assessments performed for the period 2006-2010, associated to the heavy reduction of the landings observed in the last twenty years, suggest the adoption of a plan for the recovery of this important resource as a matter of urgency. The purse seine fleet operating in the GSA 09 contemporary exploit anchovy and sardine. Therefore, all the management options that will be implemented in the future need to take into account also the effects on sardine, the other important resource exploited by this fishery.

However, taking into account the short data series available for the evaluation, further analyses should be carried out.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

In the GSA 09, anchovy is mainly exploited by purse seiners that use light for attracting fish. Due to the high economic value, anchovy represents the target species for this fleet in the GSA 09, while sardine (*Sardina pilchardus*) is the other important species exploited by this fishery. The fishing season starts in spring (March) and ends in autumn (October). Favorable weather conditions and abundance in the catches can extend the fishing activity to the end of November. However, the maximum activity of the fleet is normally observed in summer. Some vessels coming from the south of Italy (mainly from GSA 10) join the local fleet in the exploitation of this resource. Studies carried out in the Adriatic Sea in the framework of the DCF in 2005 demonstrated that discards of anchovy for the Italian fleet can be considered as negligible.

Anchovy is also a by-catch in the bottom trawl and gillnet fisheries; however, the landings done by these *metiers* are very low (about 5%) in comparison to that of purse seine. No information is available on discard for those gears. Pelagic trawling for small pelagics is not carried out in the GSA 09.

Annual landings (in tons) by year (2002-2010) in GSA 09

2002	2003	2004	2005	2006	2007	2008	2009	2010
6975	4582	1494	2108	3727	2292	1355	2378	2893

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

E_{msy} (F/Z, F_{0-3})=	≤ 0.4
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of anchovy in GSA 09 can be found in section 6.

5.17 Summary sheet of giant red shrimp (*Aristaeomorpha foliacea*) in GSA 11

Species common name:	Giant red shrimp
Species scientific name	*Aristaeomorpha foliacea*
Geographical Sub-area(s) GSA(s):	GSA 11

Most recent state of the stock

- State of the adult abundance and biomass:

Stock assessment has been computed by Length Cohort Analysis (VIT software) using DCF data of landings at age (2006-2010). Medits survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. Since no precautionary level for the stock of the giant red shrimp in GSA 11 was proposed, EWG 11-12 cannot evaluate the stock status in relation to the precautionary approach.

- State of the juvenile (recruits):

Medits length frequency distributions show the presence of a variable number of recruits in the period 1994-2010 without a clear trend. In 2006 and 2007 however a reduction in their amount can be observed. This reduction can be noted by length at age of commercial landings too.

- State of exploitation:

STECF EWG 11-12 proposes $F_{0.1} \leq 0.49$ as limit management reference point consistent with high long term yields (F_{msy} proxy). Based on the assessment results, the estimated F (average $F_{1\text{-}4} = 0.98$) exceeded the estimated reference value of $F_{0.1}$. Therefore, the EWG 11-12 classifies the stock being subject to overfishing.

- Source of data and methods:

Length cohort analysis (VIT) was computed on data of commercial landings (2006-2007-2009-2010). Discards are believed neglibible and are not considered in the assessment.

Outlook and management advice

EWG 11-12 recommends the trawling fleets' effort to be reduced until fishing mortality is below or at the proposed level F_{MSY}, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multi-annual management plan aimed at reducing the fishing effort of the relevant fleet. Catches and effort consistent with F_{MSY} should be estimated.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up meeting (16-20 January 2012) depending on data availability.

Fisheries

The giant red shrimp is a relevant target species in Sardinian waters. Fishing grounds are typical muddy bottoms from 150 to 570 m depth, but the occurrence of the species is mainly between 200 and 450 meter of depth. It is caught exclusively by otter trawl on the slope ground during all year round, with peaks in landings observed in summer. Giant red shrimps are frequently caught together with Norway lobster (*Nephrops norvegicus*), blue and red shrimp (*Aristeus antennatus*), catshark (*Galeus melastomus*), *Phycis blennoides*, *Etmopterus spinax*, Macrouridae as well as large hake (*Merluccius merluccius*).

Landings in GSA 11 showed a decrease in the period 2005-2008, falling from about 170 to 67 tons. A slow increase can be observed in the two last years (2009-2010). No discards were observed.

Nominal effort (kw·days) in GSA 11 has gradually decreased from 2004 to 2008; since then it remained rather stable.

Annual landings (in tons) in GSA 11 (2005-2010)

Area	Country	Gear	2005	2006	2007	2008	2009	2010
GSA 11	Italy	OTB	170.667	128.672	81.681	67.115	117.434	109.054

Fishing effort (kW·days) in GSA 11 (2004-2010)

Country	Area	Year	Gear	Nominal_Effort	Gt_Days_At_Sea	No_Vessels
ITA	SA 11	2004	OTB	7,706,431	1,721,988	1,805
ITA	SA 11	2005	OTB	7,324,728	1,785,484	1,713
ITA	SA 11	2006	OTB	5,752,588	1,358,732	1,825
ITA	SA 11	2007	OTB	5,865,498	1,414,252	1,833
ITA	SA 11	2008	OTB	4,430,174	1,128,009	1,473
ITA	SA 11	2009	OTB	4,375,729	1,045,910	1,665
ITA	SA 11	2010	OTB	4,041,363	944,672	1,017

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (1-4) Fmsy proxy	≤ 0.49
F_{max} (age range)=	
F_{msy} (age range)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	

Comments on the assessment

The detailed assessment of giant red shrimp in GSA 11 can be found in section 6 of this report.

5.18 Summary sheet of red mullet (*Mullus barbatus*) in GSAs 15 and 16

Species common name:	Red mullet
Species scientific name	*Mullus barbatus*
Geographical Sub-area(s) GSA(s):	GSA 15 and 16

Most recent state of the stock

- State of the adult abundance and biomass:

According to VIT analysis, absolute estimations of SSB (combined sex) in the 2006-2010 was 1070 t in 2006, 1307 t in 2007, 1046 t in 2008, 905t in 2009 and 1072 t in 2010. In the asence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

- State of the juvenile (recruits):

The estimates of absolute recruitment in millions of individuals (age class 0) from VIT analysis in 2006-2010 were 39.3 in 2006, 57.7 in 2007, 48.0 in 2008, 31.6 in 2009, and 40.2 in 2010.

- State of exploitation:

The STECF EWG 11-12 proposes F0.1=0.45 (Fmsy) as limit reference point consistent with high long term yields and low risk of fisheries collapse. The VIT assessments 2008-2010 indicate current fishing mortality in the range F=0.8. The STECF EWG 11-12 classifies the status of the stock of red mullet in the Northern sector of the Strait of Sicily as being subject ot overfishing. Thus EWG reccomends that fishing effort is reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

- Source of data and methods:

Five complete years (2006-2010) of length frequency distributions from GSA 16 commercial landings data (fished in GSA 15 as well as GSA 16) were available, so an approach under steady state (pseudocohort) assumptions was used. Cohort (VPA equation) and Y/R analysis as implemented in the package VIT4win were used. Data were derived from the DCF data call for GSA 15 (total landings data only) and 16 (LFDs as well as total landings data). Discards may be significant but were not considered in the assessment. In addition, fishery independent information regarding the state of the red mullet in GSAs 15 and 16 was derived from the international survey MEDITS and the Italian survey GRUND. Trends in abundance and biomass indices as well as length frequency distributions were plotted.

- Data quality and availability:

STECF EWG 11-12 noted a lack of discards information for *Mullus barbatus* in GSA 15 and GSA 16.

Outlook and management advice

A reduction of about 40% of the fishing mortality would be needed to reach the target reference points $F_{0.1}$=0.45 (median value of the 2006-2010 assessment). However the stock showed an increasing trend of both SSB and recruitment indices from trawl surveys. This could be correlated with the reduction of illegal trawling in the coastal areas within the 50 m depth where the recruitment of the species occur in late summer-early autumn, the reduction of fishing effort since 2008 and/or to the positive effect of warming of the surface seawater on the recruitment success.

Short and medium term scenarios:

The short and medium term projections of stock biomass and catches will be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

Red mullet (*M. barbatus*) is one of the main demersal resources of the coastal areas in the Mediterranean, fished by otter trawl and trammel and gill-net, together with several other species (Voliani, 1999). Red Mullet is caught together with other important species such as *Mullus surmuletus, Merluccius merluccius, Pagellus sp., Uranoscopus scaber, Raja sp., Trachinus sp., Octopus vulgaris, Sepia officinalis, Eledone sp.* and *Lophius sp*. In GSA 15 and 16 red mullet is caught almost exclusively by inshore trawlers operating on shelf fishing-grounds of GSA 16 and 15.

Annual landings (in tons) by fishing technique as reported to STECF EWG 11-12 through the DCF data call.

Species	Area	Country	Gear	2005	2006	2007	2008	2009	2010
MUT	16	ITA	GTR	29	39	37	20	13	0
MUT	16	ITA	OTB	1377	1084	1343	1157	787	757
MUT	16	Total ITA	n/a	1406	1123	1380	1177	801	757
MUT	15	MLT	GTR	1.01	0.75	0.50	0.42	0.35	1.02
MUT	15	MLT	OTB	1.9	7.0	0.5	13.8	8.9	12.3
MUT	15	Total MLT	n/a	3	8	1	14	9	13
MUT	**15&16**	**ITA&MLT**	**Total**	**1409**	**1131**	**1381**	**1191**	**810**	**770**

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (1-4) Fmsy proxy	≤0.45
F_{max} (age range)=	Due to the shape of the YPR curve, the estimation of F_{max} is not reliable.
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of red mullet in GSA 15 and 16 can be found in section 6 of this report.

5.19 Summary sheet of giant red shrimp (*Aristaeomorpha foliacea*) in GSAs 15 and 16

Species common name:	Giant red shrimp
Species scientific name	*Aristaeomorpha foliacea*
Geographical Sub-area(s) GSA(s):	GSA 15 and 16

Most recent state of the stock

- <u>State of the adult abundance and biomass:</u>

STECF EWG 11-12 estimated the absolute levels of the female stock abundance in 2006-2010 by VIT approach on length structure of Sicilian trawlers which catch about 98% of the total yield in the area. Mean biomass at sea range between 1070 t (2006) and 1580 t (2009), female SSB representing about 70 and 75% of the total population. In the absence of a precautionary biomass reference point STECF EWG 11-12 is unable to fully evaluate the state of the stock size.

- <u>State of the juvenile (recruits):</u>

Absolute estimate of female recruitment (18-22 mm CL) from VIT ranged between 83 (2008) and 123 (2010) millions of recruits.

- <u>State of exploitation:</u>

STECF EWG 11-12 proposes F0.1=0.4 (Fmsy proxy) as limit management reference point of the female part of the stock consistent with high long term yield and low risk of fisheries collapse. The female giant red shrimp stock in the Northern sector of the Strait of Sicily is considered to be subject of overfishing since the current fishing mortality F=1.09 exceeds this reference point.

- <u>Source of data and methods:</u>

Only the female component of the stock has been assessed. Five complete years (2006, 2007, 2008, 2009 and 2010) of length frequency distributions from GSA 16 commercial landings data (fished in GSA 15 as well as GSA 16) were available, as well as two years (2009 and 2010) from GSA 15, so an approach under steady state (pseudocohort) assumptions was used. Discards are believed to be negligible and are not considered in the stock assessment. Cohort (VPA equation) and Y/R analysis as implemented in the package VIT4win were thus used. Data were derived from DCF data call for GSA 15 and 16.

Outlook and management advice

The stock assessments performed during STECF EWG 11-12 confirmed the diagnosis obtained in previous workshop. Considering $F_{0.1}$ as limit reference point, a reduction ranging between 50 and 60 % of the current F in 2009 and 2010 is needed to reach a sustainable fishery exploitation.

The EWG was informed that the Italian government has adopted a management plan in which a reduction of trawler capacity of 25% by 2013 is foreseen of compared with 2008. STECF EWG 11-12 recommends to continuously reduce current F through consistent effort reductions and an improvement in current exploitation patterns.

<u>Short and medium term scenarios:</u>

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up meeting (16-20 January 2012) depending on data availability.

Fisheries

The giant red shrimps is a relevant target species of the Sicilian and Maltese trawlers and is caught on the slope ground during all year round, but landing peaks are observed in summer. *A.foliacea* is fished exclusively by otter trawl, mainly in the central–eastern side of the Strait of Sicily, whereas in the western side it is substituted by the violet shrimp, *Aristeus antennatus*. Giant red shrimps are frequently caught together with Norway lobster (*Nephrops norvegicus*), large sized deep water pink shrimp (*Parapenaeus longirostris*), the more rare violet shrimp (*Aristeus antennatus*) as well as large hake (*Merluccius merluccius*).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (2-7) Fmsy proxy	≤ 0.4
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of giant red shrimp in GSA 15 and 16 can be found in section 6 of this report.

5.20 Summary sheet of common Pandora (*Pagellus erythinus*) in GSA 15 and 16

Species common name:	Common pandora
Species scientific name	*Pagellus erythinus*
Geographical Sub-area(s) GSA(s):	GSA 15 and 16

Most recent state of the stock

- State of the adult abundance and biomass:

According to VIT analysis, absolute estimations of SSB (combined sex) in the 2006-2009 was 1070 t in 2006, 1307 t in 2007, 1046 t in 2008, 905t in 2009 and 1072 t in 2010. Since the value of 2009 are not consistent, the parental stock seems to be quite stable. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

- State of the juvenile (recruits):

The estimates of absolute recruitment in millions of individuals (age class 1) from VIT analysis were 15.2 in 2006, 8.1 in 2007, 7.1 in 2008, 5.1 in 2009, and 3.9 in 2010. Value estimated in 2009 is considered unreliable.

- State of exploitation:

STECF EWG 11-12 proposes $F_{0.1}$= 0.30 (Fmsy proxy) as limit reference point consistent with high long term yields and low risk of fisheries collapse. Since the current fishing mortality is higher than $F_{0.1,}$ the stock of common Pandora in the Northern sector of the Strait of Sicily is assessed being subject to overfishing.

- Source of data and methods:

Five complete years (2006, 2007, 2008, 2009 and 2010) of length frequency distributions from GSA 16 commercial landings data (fished in GSA 15 as well as GSA 16) were available, so an approach under steady state (pseudocohort) assumptions was used. Discard information was unavailable and is therefore not considered in the assessment. Cohort (VPA equation) and Y/R analysis as implemented in the package VIT4win were thus used. Age structure of landings was derived from the DCF data call for GSA 16. Total landing included the yield of both the Italian and Maltese fleet.

Outlook and management advice

Considering the Sicilian fleet operating in GSAs 15-16, for which both commercial data were available, a reduction of about 50% of the fishing mortality needs to reach the limit reference point $F_{0.1}$. However the stock does not shown sign of decrease of SSB and recruitment indices from trawl surveys.

The working group was informed that the Italian government has adopted a management plan in which a reduction of trawler capacity of 25% by 2013 is foreseen as compared with 2008. EWG 11-12 recommends to continuously reduce current F through consistent effort reductions, and an improvement in current exploitation patterns.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up meeting (16-20 January 2012) depending on data availability.

Fisheries

Common Pandora is an important demersal fishery resource through the Mediterranean, including in the Strait of Sicily (Gancitano et al. 2010b). Trawling is carried out on the continental shelf of the Central Mediterranean throughout the year, and catches include common Pandora (*Pagellus erythrinus*), pink shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), giant red shrimp (*Aristaeomorpha foliacea*), violet shrimp hake (*Merluccius merluccius*), violet shrimp (*Aristeus antennatus*), scorpionfish (*Helicolenus dactylopterus*), grater forkbeard (*Phicys blennioides*), red Pandora (*Pagellus bogaraveo)* and monkfish (*Lophius piscatorius*). In addition to trawling, common Pandora is targeted by several artisanal gears, including set gillnets, trammel nets, pots and traps and set longlines.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (ages 2-7) Fmsy proxy	≤ 0.3
F_{max} (age range)=	Due to the shape of the curve, the estimation of F_{max} is not reliable.
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of common Pandora stock in GSA 15 and 16 can be found in section 6 of this report.

5.21 Summary sheet of anchovy in GSA 16

Species common name:	Anchovy
Species scientific name	*Engraulis encrasicolus*
Geographical Sub-area(s) GSA(s):	GSA 16

Most recent state of the stock

- State of the adult abundance and biomass:

Biomass estimates of total population obtained by hydro-acoustic surveys for anchovy in GSA 16 show a decreasing trend over the last decade, despite the occurrence of quite large inter-annual fluctuations, from a maximum of about 22,900 t in 2001 to a minimum of 3,100 t in 2008. Biomass estimates over the period 2006-2009 surveys were the lowest of the series (their average representing less than one-quarter of the maximum recorded value). However, anchovy stock biomass experienced a significant increase in 2010. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

- State of the juvenile (recruits):

No recruitment data were estimated within this assessment.

- State of exploitation:

EWG 11-12 recommends E=0.4 as limit management reference point consistent with high long term yields. The high and increasing yearly harvest rates, as estimated by the ratio between total landings and stock sizes, might indicate high fishing mortality levels. The current (2010) harvest F is 0.28, whereas the estimated average value over the years 2007-2010 is 0.67. The exploitation rate corresponding to F=0.67 is E=0.50, if M=0.66, estimated with Pauly (1980) empirical equation, is assumed, and E=0.54 if M=0.56, estimated with Beverton & Holt's Invariants method (Jensen, 1996), is used instead. Using the exploitation rate as a reference point, this stock should be considered as being subject to overfishing.

- Source of data and methods

Data for catch and effort were obtained from census information (on deck interviews) in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA16), accounting for about 2/3 of total landings in GSA 16. Discards are believed to be negligible and are not considered in the assessment. Acoustic data were used for fish biomass evaluations. Von-Bertalanffy growth parameters were estimated by FISAT with DCF data collected in GSA16 over the period 2007-2009. For BHI method, the equation $M = \beta * k$ was applied, with β set to 1.8 and k = 0.40. Anchovy was assessed using a non-equilibrium surplus production model based on the Schaefer (logistic) population growth model.

Outlook and management advice

Results of the adopted modelling approach suggest that the environmental factors can be very important in explaining the variability in yearly biomass levels (mostly due to recruitment success) and indicate that the stock status was well below the B_{MSY} during the considered period.

STECF EWG 11-12 notes that mere effort management of fisheries targeting stocks of small pelagics implies a high risk due to their schooling behavior and the multi-species character of their fisheries (changing target species as available and appropriate). EWG 11-12 rather recommends the consideration of landing restrictions as a more effective management tool for small pelagics. EWG recommends a multi-annual management plan being implemented taking into account mixed-fisheries effects, in particular the technical relation with anchovy fisheries. In addition, due to the low level of the anchovy stock, measures should be taken to prevent a shift of effort from anchovy to sardine.

- Short, medium and long term scenarios

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up meeting (16-20 January 2012) depending on data availability.

Fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 vessels (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the high market price. Average sardine landings in Sciacca port over the period 1998-2010 were about 1,400 metric tons, with a general decreasing trend. The catches dramatically decreased in 2010 (-70%).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

E msy (F/Z, F age range)	≤ 0.4
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of anchovy in GSA 16 can be found in section 6 of this report.

5.22 Summary sheet of common sardine (*Sardina pilchardus*) in GSA 16

Species common name:	Sardine
Species scientific name	*Sardina pilchardus*
Geographical Sub-area(s) GSA(s):	GSA 16

Most recent state of the stock

- <u>State of the adult abundance and biomass:</u>

Biomass estimates of the total population obtained by hydro-acoustic surveys for sardine in GSA 16 show that the recent stock level has been below the average value over the period 1998-2010. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

- <u>State of the juvenile (recruits):</u>

No recruitment data estimates were provided by this assessment.

- <u>State of exploitation:</u>

STECF EWG 11-12 recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea, though this value might be revised in the future when more information becomes available. The current (year 2010) harvest F is unusually low (0.04) compared to the estimated average value over the years 2007-2010 (0.15). The very low harvest rate for 2010 appears to be the result of a change in the fishing pattern in favour of anchovy, as the fishing effort remained relatively stable. The exploitation rate corresponding to F=0.15 is equal to E=0.16, if M=0.77, estimated with Pauly (1980) empirical equation, is assumed, and E=0.17 if M=0.72, estimated with Beverton & Holt's Invariants method (Jensen, 1996), is used instead. Thus, using the exploitation rate as a target reference point, the stock of sardine in GSA 16 would be considered as being sustainably exploited.

- <u>Source of data and methods:</u>

Data for catch and effort were obtained from census information (on deck interviews) in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16. Discards are believed to be negigilbe and are not considered in this assessment. Acoustic data were used for fish biomass evaluations. Von-Bertalanffy growth parameters, necessary for the calculation of natural mortality, were estimated by FISAT with DCF data collected in GSA16 over the period 2007-2009. For BHI method, the equation $M = \beta * k$ was applied, with β set to 1.8 and k = 0.40. The sardine stock in the area was also assessed using a non-equilibrium surplus production model based on the Schaefer (logistic) population growth model.

Outlook and management advice

STECF EWG 11-12 notes that mere effort management of fisheries targeting stocks of small pelagics implies a high risk due to their schooling behavior and the multi-species character of their fisheries (changing target species as available and appropriate).EWG 11-12 rather recommends the consideration of landing restrictions as a more effective management tool for small pelagics. EWG 11-12 recommends a multi-annual management plan being implemented taking into account mixed-fisheries effects, in particular the technical relation with anchovy fisheries.

Short and medium term scenarios:

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up meeting EWG 11-20 (16-20 January 2012) depending on data availability.

Fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 vessels (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

Average sardine landings in Sciacca port over the period 1998-2010 were about 1,400 metric tons, with a general decreasing trend. The production largely decreased in 2010 (-70%).

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

Emsy= (F/Z, F age range)	≤ 0.4
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

The detailed assessment of sardine in GSA 16 can be found in section 6 of this report.

5.23 Summary sheet of common sole (*Solea solea*) in GSA 17

Species common name:	Common sole
Species scientific name	*Solea solea*
Geographical Sub-area(s) GSA(s):	GSA 17

Most recent state of the stock

- <u>State of the adult abundance and biomass:</u>

According to the XSA and SURBA analyses the SSB was practically constant in the period considered but, taking into account the high values of relative F for the oldest ages, the stock is considered overexploited. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the state of the stock size.

- <u>State of the juvenile (recruits):</u>

According to XSA and SURBA analyses the recruitment of sole in GSA 17 fluctuated since 2005 without a clear trend.

- <u>State of exploitation:</u>

The STECF EWG 11-12 propsed F0.1=0.26 (Fmsy proxy) as limit management reference point consistent with high long term yields and low risk of fisheries collapse. Based on the XSA estimates, in 2010 the fishing mortality F=1.2 exceeds $F_{0.1}$ and, hence, it can be concluded that the resource is subject to overexploitation.

- <u>Source of data and methods:</u>

EWG 11-12 has updated the assessment carried out during the SGMED 10-02 with 2010 fishery dependent and independent data coming from both DCF official data call and SoleMon project. For sole in GSA17 landings at age and at length were available only for beam trawl from 2006 to 2010, no data from gillnet and otter trawl were available for the same time period. Moreover a difference in the selectivity pattern of 2009-2010 rapido trawl landings compared to the previous year were observed. As regarding the total landings, there is a high level of similarity comparing the official DCR data and the data collected in the framework of SoleMon project used in the previous assessment. Differences in the comparison between total landing data submitted in the previous official DCF data and 2011 official DCF data were observed. Discards are believed negligible and are not considered in the assessment.

Outlook and management advice

EWG 11-12 recommends reducing fishing mortality towards the proposed reference point F_{MSY}. A change in the exploitation pattern is also reccomended, taking into account that the exploitation is mainly orientated towards juveniles. Moreover, information provided by VMS will be useful in order to quantify the fishing effort of rapido trawlers (i.e the main fleet fishing sole) in different areas and period. Specific studies on rapido trawl selectivity are necessary. In fact, it is not sure that the adoption of a larger mesh size would correspond to a decrease in juvenile catches. The same uncertainty regards the adoption of square mesh.

<u>Short and medium term scenarios:</u>

Short and medium term predictions of stock biomass and catches are planned to be accomplished during the follow-up STECF EWG 11-20 meeting (16-20 January 2012) depending on data availability.

Fisheries

The Italian fleets exploit this resource with *rapido* trawl and set nets (gill nets and trammel nets), while only trammel net is used in the countries of the eastern coast of GSA 17 in the Adriatic Sea. Sole is an accessory species for otter trawling. More than 90% of catches come from the Italian side. Landings fluctuated between 1,000 and 2,300 tons in the period 1996-2010 (data source: FAO-FishStat; ISMEA-SISTAN and 2011 official data call). The fishing effort applied by the Italian *rapido* trawlers gradually increased from 1996 to 2005, and slightly decreased in the last years.

Exploitation is based on 1 and 2 year old individuals. In the last years, the annual landings of this species were around 2000 tons in the overall GSAs. Otter and *rapido* trawlers carry out their activity all year round, with the only exception of the fishing ban (end of July – beginning of September), while set netters show a seasonal activity (spring-fall). The fishing grounds exploited by rapido trawlers extend from 5.5 km from the shoreline to 50-60 m depth, while otter trawlers carry out their activity in the overall area, except for the Croatian waters. Set netters operate in the shallower waters usually close to the fishing harbors.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-05

$F_{0.1}$ (Y/R, sexes combined, ages 0-4) Fmsy proxy	≤ 0.26
F_{max} (age range)=	0.46
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

Lack of length and age catch composition has been observed for different years for GNS and OTB. Moreover the comparison between total landings submitted in 2011 DCF official data call and previous DCF official data showed some discrepancies.

The detailed assessment of common sole in GSA 17 can be found in section 6 of this report.

5.24 Summary sheet of picarel (*Spicara smaris*) in GSA 25

Species common name:	Picarel
Species scientific name	*Spicara smaris*
Geographical Sub-area(s) GSA(s):	GSA 25

Most recent state of the stock

- State of the adult abundance and biomass:

In the absence of proposed or agreed precautionary refernce points stecf EWG 11-12 is unable to fully evaluate the status of the spawning stock size. In the current XSA stock assessment no short term trend in the spawning stock biomass is evident.

- State of the juvenile (recruits):

Recruitment varied without any trend in the years 2005-2010.

- State of exploitation:

STECF EWG 11-12 proposes F0.1 = 0.314 (Fmsy proxy) as limit management reference point consistent with high long term yields and low risk of fisheries collapse. In relation to the estimated values of current F (0.06 and 0.08), EWG 11-12 classifies the stock's exploitation status as sustainable.

- Source of data and methods:

EWG 11-12 has performed for the first time an assessment on this stock. XSA based assessment and ASPIC based production model were carried out during EWG 11-12.

Catch at age data showed different exploitation patterns in the years, perhaps linked with different approaches in otolith reading. Discards may be significant but were not included in the assessment due to lack of knowledge. Differences in the comparison between total landing data submitted in the previous official DCF data and 2011 official DCF data were observed only in 2005 and 2006 of 18%.

Outlook and management advice
Future fisheries shall be maintained at a sustainable level with all mixed fisheries facts being taken into consideration.

Short and medium term scenarios:
Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up STECF EWG meeting (16-20 January 2012) depending on data availability.

Fisheries

The Cyprus bottom trawl and the small scale inshore fishery target a mix of demersal species, as it is the case in all Mediterranean demersal fisheries. The exploited stocks are not shared with other countries' fleets. Landings of both fisheries are mainly composed by *Spicara* spp. (*Spicara smaris* and *Spicara maena*), *Boops boops*, *Mullus barbatus*, *M. surmuletus*, *Pagellus erythrinus* and cephalopods. The inshore fishery catches also relatively large quantities of *Diplodus* spp., *Sparisoma cretense* and *Siganus* spp.

The Cypriot fleets exploit picarel with otter trawl and set nets (gill nets and trammel nets), while only occasionally purse seine has been utilized. Picarel is an accessory species for gill netters, and in the last years around 80% of catches come from OTB, for this fleet picarel represent in weight more than 60% of the total landing. OTB exploits mainly 0 and 1 year old individuals, while older age classes of the population are exploited by the gill netters.

Limit and precautionary management reference points

Table of limit and precautionary management reference points proposed by STECF EWG 11-12

$F_{0.1}$ (Y/R, sexes combined, ages 0-4) Fmsy proxy	≤0.31 (from production model)
F_{max} (age range)=	0.46
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Table of limit and precautionary management reference points agreed by fisheries managers

$F_{0.1}$ (mean)=	
F_{max} (age range)=	
F_{msy} (age range)=	
F_{pa} (F_{lim}) (age range)=	
B_{msy} (spawning stock)=	
B_{pa} (B_{lim}, spawning stock)=	

Comments on the assessment

Picarel 2011 DCF data in GSA25 are delivered by Cyrpus. No major data deficiencies have been observed for this stock.

The detailed assessment of picarel in GSA 25 can be found in section 6 of this report.

6 ToR A-E UPDATE AND ASSESS HISTORIC AND RECENT STOCK PARAMETERS (DETAILED ASSESSEMENTS)

The following section of the present report does provide detailed stock specific assessments and all relevant data of such stocks and their fisheries. Unlike earlier years, the assessments are presented in geographic order by GSA, and not any longer by species. The format of the assessments has been agreed by the experts in 2008. Short versions of the assessments of stocks and fisheries in the format of summary sheets are provided in the preceding section 5.1 in cases when the analyses resulted in an analytical assessment of the stock status.

6.1 Stock assessment of European hake in GSA 01

6.1.1 Stock identification and biological features

6.1.1.1 Stock Identification

The delimitation of the hake stock in GSA 01 is considered largely unknown. Likely connections with hake in GSA 06 may exist, because of the continuity of shelf. Large exchanges with the south Alboran Sea (GSA 03) are believed insignificant.

6.1.1.2 Growth

Growth parameters (Linf= 106.7; k= 0.2; to= 0.003), taken from García- Rodriguez (2002) and estimated through otolith readings and length distributions analysis, correspond to fast growth for the species. The length- weight relationship parameters used are a=0.0048 and b=3.12, from García- Rodríguez and Esteban (1995). These parameters are the same used in the assessment of hake in SA06.

6.1.1.3 Maturity

Maturity ogive was taken from García- Rodríguez and Esteban (1995), with size at first maturity (50 %) at 33 cm TL.

ages	0	1	2	3	4	5+
% mature	0	0.15	0.82	0.98	1	1

6.1.2 Fisheries

6.1.2.1 General description of fisheries

The STECF expert working group will provide a description during its nex assessment of the stock.

6.1.2.2 Management regulations applicable in 2010 and 2011

No information was documented during EWG 11-12.

6.1.2.3 Catches

6.1.2.3.1 Landings

The following table shows the trend in landings as obtained from the DCF data call in 2010.

Table 6.1.2.3.1.1 DCF landings (t) of hake in GSA 01, 2002-2010.

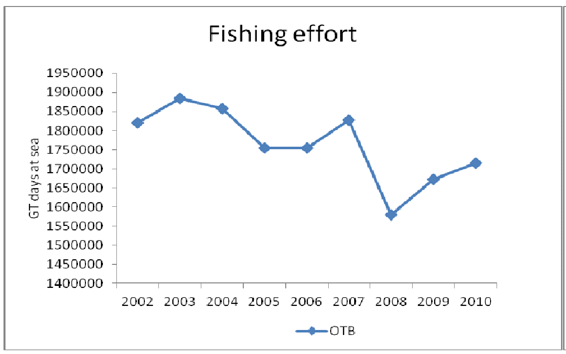
GEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010
GNS	40.498	37.015	30.840	35.265	48.481	39.379	37.300	17.179	9.747
GTR								32.770	16.029
LLS	44.387	13.548	2.308	6.110	12.361	5.673	6.671	5.541	20.602
OTB	451.088	415.798	515.819	295.813	282.940	274.939	282.299	563.709	529.875

6.1.2.3.2 Discards

Discards data submitted for OTB. Discards in weight are considered very low. No data was provided on the discards sizes.

6.1.2.4 Fishing effort

Data on fishing effort was provided for OTB, GNS, GTR and LLS over the period 2002-2010, on a quarterly basis.



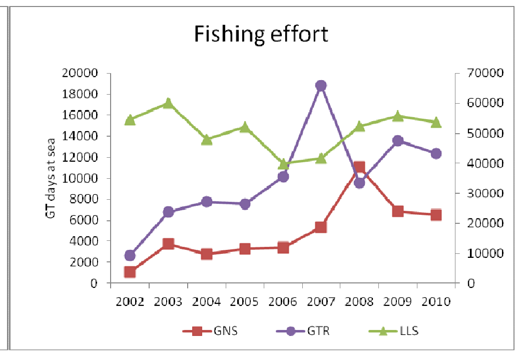


Fig. 6.1.2.4.1 Annual fishing effort (GT*days at sea) for OTB (left) and LLS, GTR and GNS (right; LLS left axis; GTR and GNS right axis).

Table 6.1.2.4.1 Annual fishing effort (GT*days at sea) by fishing technique (2002-2010)

	OTB	GNS	LLS	GTR
2002	1820400.7	1058.9	54697.2	2661.6
2003	1884439.3	3721.8	60053.0	6773.5
2004	1857233.9	2735.6	48125.8	7780.8
2005	1754924.3	3310.4	52131.0	7544.7
2006	1753904.5	3420.2	39849.6	10138.8
2007	1827621.1	5370.8	41588.7	18859.3
2008	1579403.4	11079.4	52451.9	9600.4
2009	1671765.2	6872.0	55861.6	13611.2
2010	1715257.6	6550.5	53666.9	12374.2

6.1.3 Scientific surveys

6.1.3.1 MEDITS

6.1.3.1.1 Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 01 the following number of hauls was reported per depth stratum (Tab. 6.1.3.1.1.1).

Tab. 6.1.3.1.1.1. Number of hauls per year and depth stratum in GSA01, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA01_010-050	2	1	2	2	2	2	2	3	3	3	3	2	3	3	4	2	3
GSA01_050-100	5	4	5	5	5	7	6	4	6	10	7	7	6	6	6	7	6
GSA01_100-200	3	3	3	5	5	5	5	4	8	6	5	6	5	6	6	6	4
GSA01_200-500	7	9	11	10	7	11	12	10	11	11	13	11	11	11	11	11	6
GSA01_500-800	6	9	12	10	12	12	9	13	13	14	13	11	15	10	7	5	6

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration.

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$
$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$
Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = $Yst \pm t(\text{student distribution}) * V(Yst) / n$

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.1.3.1.2 Geographical distribution patterns

No information was documented during EWG 11-12.

6.1.3.1.3 Trends in abundance and biomass

Figure 6.1.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 01. The estimated abundance and biomass indices do not reveal a clear trend.

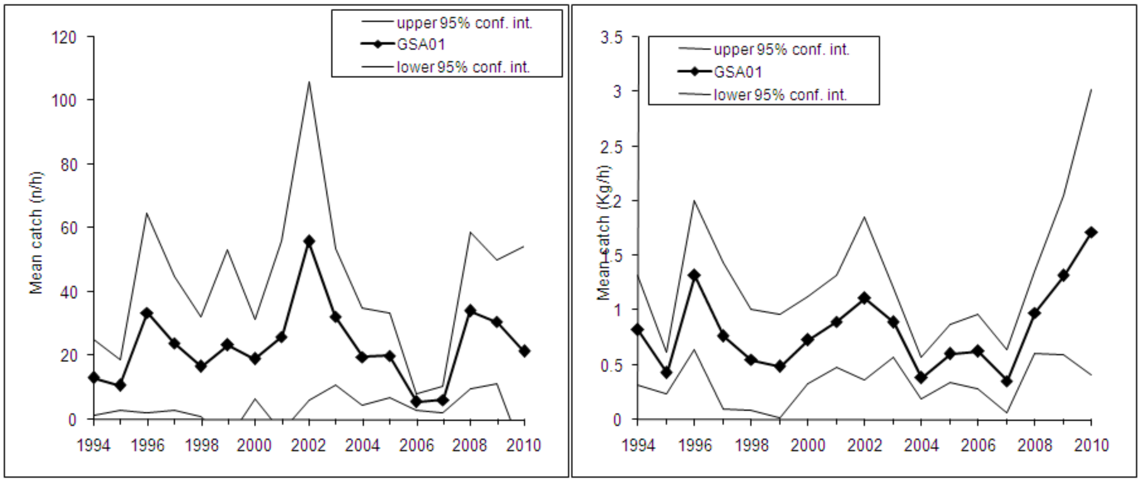
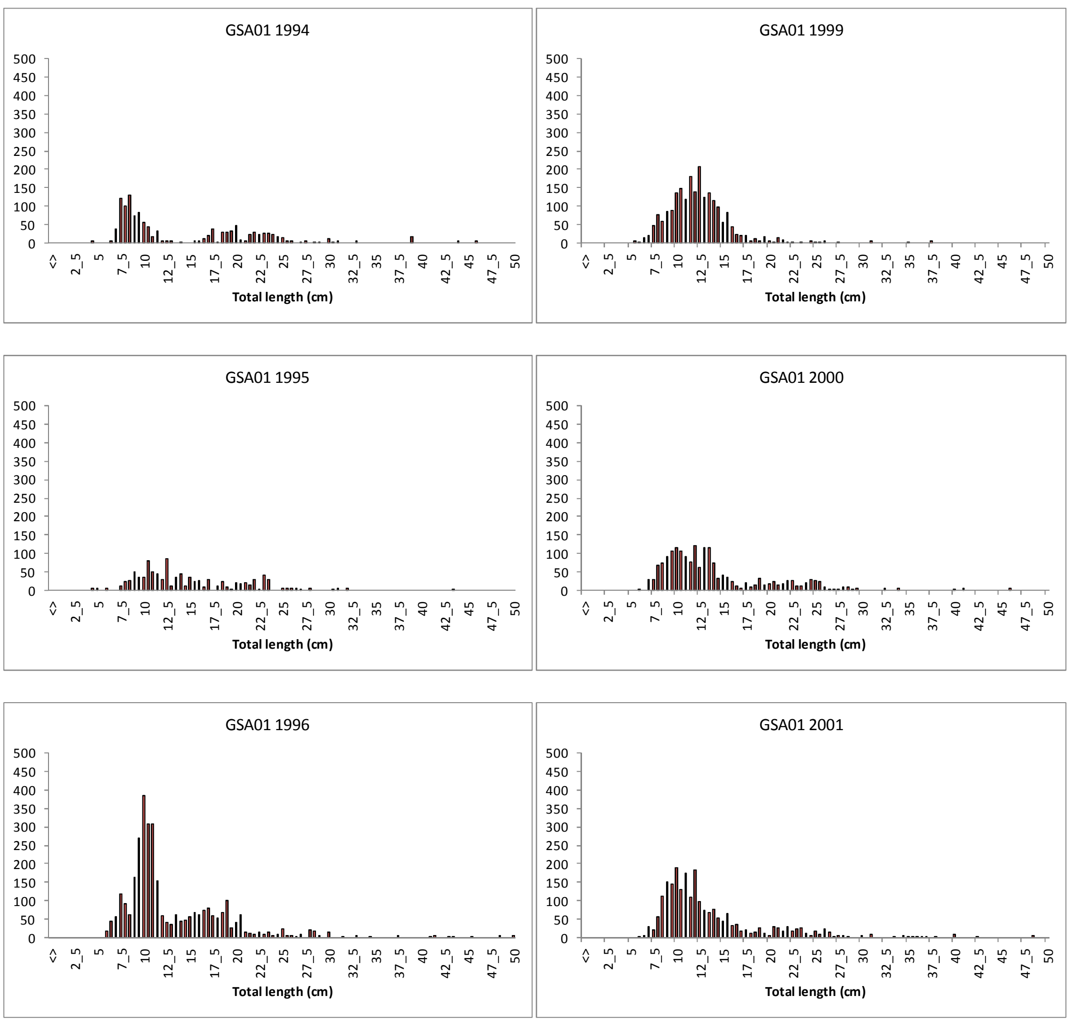
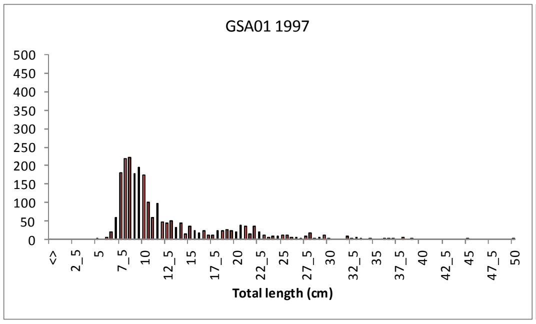
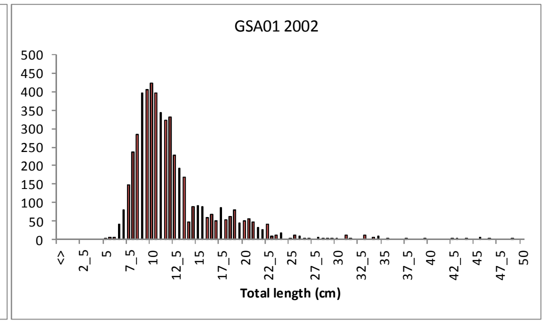


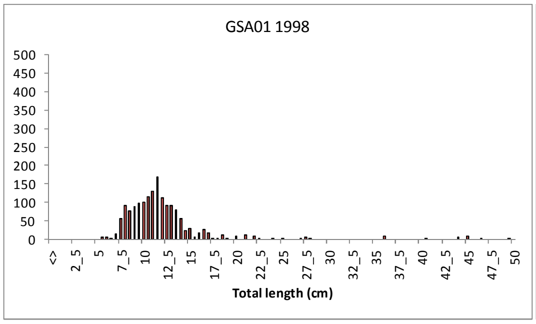
Fig. 6.1.3.1.3.1 Abundance and biomass indices of hake in GSA 01.

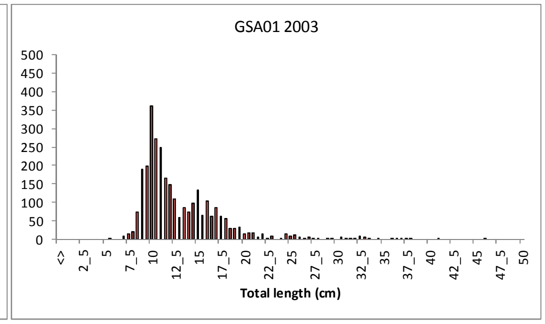
6.1.3.1.4 Trends in abundance by length or age

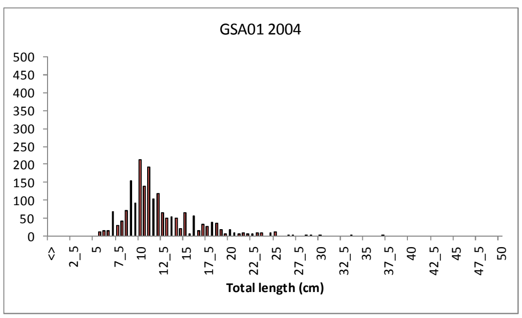


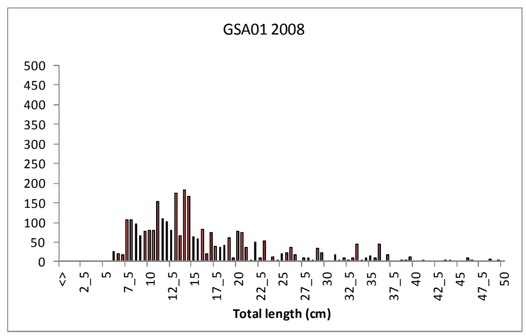

GSA01 1997
Total length (cm)

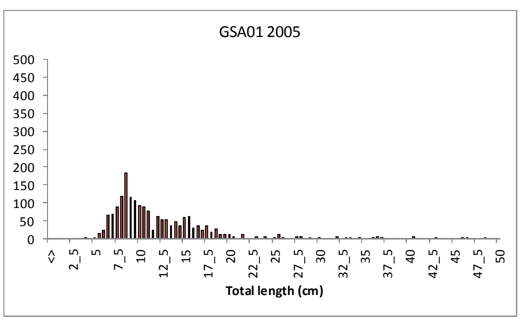

GSA01 2002
Total length (cm)

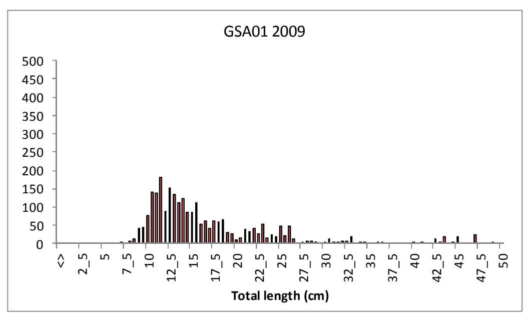

GSA01 1998
Total length (cm)

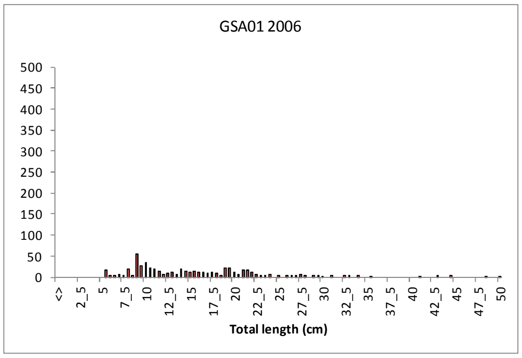

GSA01 2003
Total length (cm)

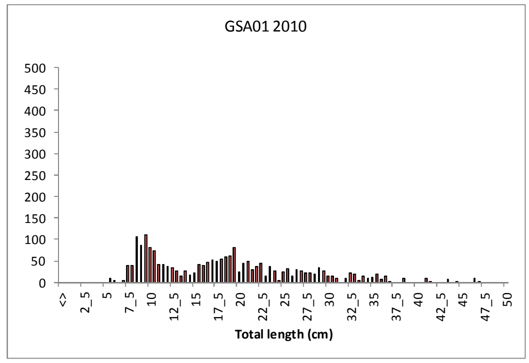

GSA01 2004
Total length (cm)


GSA01 2008
Total length (cm)


GSA01 2005
Total length (cm)


GSA01 2009
Total length (cm)





6.1.3.1.5 Trends in growth

No information has been documented.

6.1.3.1.6 Trends in maturity

No information has been documented.

6.1.4 Assessments of historic stock parameters

6.1.4.1 Method 1: LCA

6.1.4.1.1 Justification

This is the first time to use this method fro the assessment of hake stock in GSA 01. The most recent assessment (EWG11-05) was made through VIT pseudo-cohort analysis applied using data from 2008 and 2009. XSA was run considering age classes 0 to 5+.

6.1.4.1.2 Input parameters

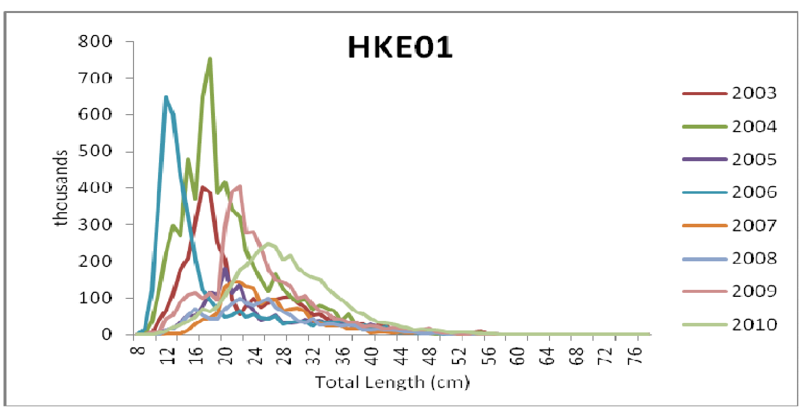


Figure 6.1.4.1.2.1. Length distributions of total landings 2003-2010 (all gears combined).

The length frequencies of landings are illustrated in the following Figure 6.1.4.3.2.1. The length frequencies on the period 2002 to 2010, show a first modal value between 10 and 15 cm, especially in 2006, and another modal class around 20 cm, which moved to the 25 cm in the last year (2010).

	Hake GSA01		Catch at age					
AGE	2003	2004	2005	2006	2007	2008	2009	2010
0	1784	3312	402	2982	153	292	665	303
1	1499	2854	1051	697	1365	1003	2978	2818
2	281	271	260	234	151	203	314	602
3	65	30	38	30	26	30	48	70
4	3	3	2	1	5	5	2	3
+gp	1	1	1	2	0	1	1	0

Hake GSA01 Weight at age (kg)

AGE	2003	2004	2005	2006	2007	2008	2009	2010
0	0,031	0,03	0,033	0,018	0,036	0,03	0,029	0,032
1	0,132	0,115	0,119	0,139	0,126	0,133	0,12	0,156
2	0,484	0,446	0,483	0,46	0,479	0,479	0,494	0,461
3	1,096	1,152	1,045	1,009	1,016	1,116	1,018	1,074
4	1,857	1,834	1,884	1,638	1,93	2,009	1,796	1,736
+gp	2,427	3,885	3,303	2,636	0	2,647	2,541	2,894

Natural mortality was estimated using PROBIOM. M at the mid-point of the year was selected as M representative for that annual class.

Natural Mortality (M) at age

AGE	0	1	2	3	4	5+
	1,24	0,61	0,48	0,43	0,4	0,38

Tuning parameters MEDITS (2003-2010)

	0	1	2	3	4
2003	2754,5	226,9	21,8	0	0
2004	144,2	134,6	3,1	0	0
2005	114,7	117,1	30,1	3,7	2,6
2006	52	153,8	11,3	14,4	2,1
2007	165,3	1010,4	31	15	0
2008	245,2	629,3	114,2	26,4	0
2009	263,8	524,4	92,2	5	2,5
2010	261	780,3	91,7	9,6	0

6.1.4.1.3 Results

Hake XSA model diagnostics are shown in Fig. 6.1.4.1.3.1 and Table 6.1.4.1.3.1.

Fig. Log catchability residual plots (XSA) for single fleets, MEDITS

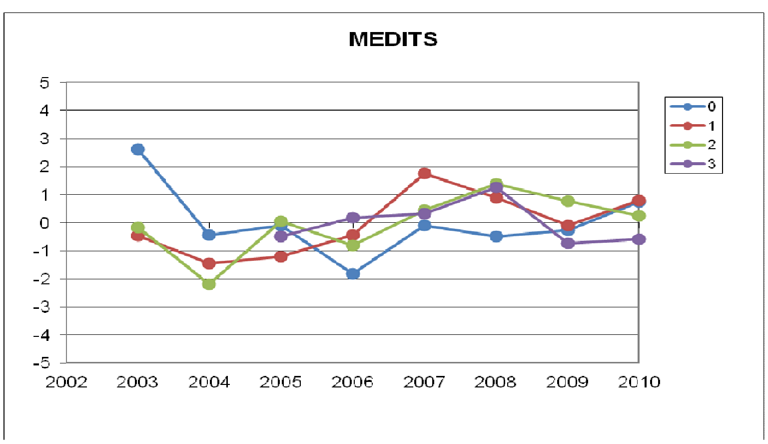


Fig. 6.1.4.1.3.1 Trends in log catchability residuals by age.

Table 6.1.4.1.3.1 Hake XSA model diagnosis

Log catchability residuals.

	2003	2004	2005	2006	2007	2008	2009	2010
0	2,63	-0,44	-0,08	-1,81	-0,08	-0,49	-0,25	0,76
1	-0,47	-1,44	-1,2	-0,44	1,75	0,89	-0,1	0,8
2	-0,17	-2,18	0,07	-0,8	0,46	1,4	0,77	0,25
3			-0,48	0,18	0,32	1,26	-0,72	-0,58
4			1,67	1,6			0,96	

Regression weights

2003	2004	2005	2006	2007	2008	2009	2010
.877	.921	.954	.976	.990	.997	1.000	1.000

Fishing mortality at age as estimated by XSA

Fishing mortality (F) at age

AGE	2003	2004	2005	2006	2007	2008	2009	2010
0	0,19	0,61	0,14	0,49	0,03	0,03	0,07	0,09
1	1,28	1,80	1,12	1,08	1,32	0,84	1,16	1,49
2	1,85	1,67	1,57	1,58	1,31	1,22	1,23	1,42
3	2,63	2,41	2,86	1,19	1,12	1,91	2,22	1,94
4	1,53	1,67	1,45	1,10	0,96	1,02	1,17	1,27
+gp	1,53	1,67	1,45	1,10	0,96	1,02	1,17	1,27
FBAR0-2	1,11	1,36	0,94	1,05	0,89	0,69	0,82	1,00
F0-5+	1,50	1,64	1,43	1,09	0,95	1,00	1,17	1,25

Summary of stock parameters as estimated by XSA

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR0-2	F0-5+
2003	19352	1281	326	449	1,38	1,11	1,50
2004	13464	1186	293	563	1,92	1,36	1,64
2005	5693	701	261	297	1,14	0,94	1,43
2006	14272	694	236	285	1,20	1,05	1,09
2007	8567	822	219	277	1,26	0,89	0,95
2008	20918	1196	265	276	1,04	0,69	1,00
2009	18304	1598	414	566	1,36	0,82	1,17
2010	6624	1566	614	779	1,27	1,00	1,25
Arith Mean	13399	1130	329	437	1,32	0,98	1,25
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)			

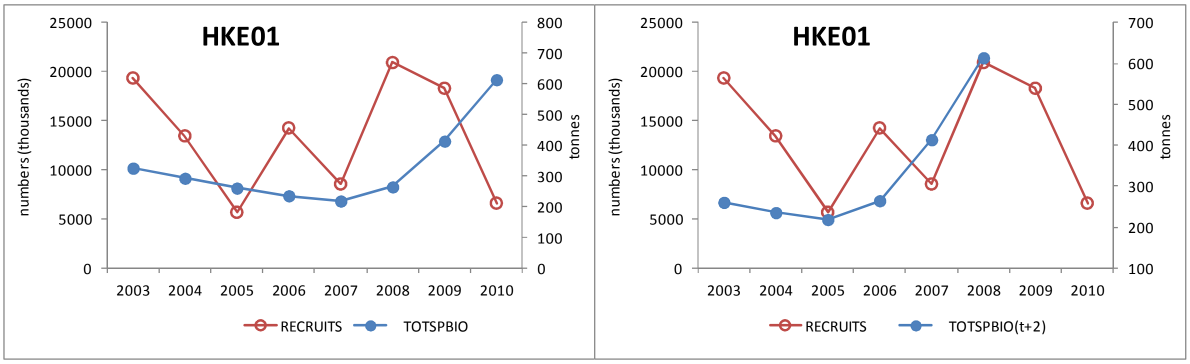


Fig. 6.1.4.1.3.2 Relationship between recruitment and SSB the same year (left) and considering a two-years lag in SSB.

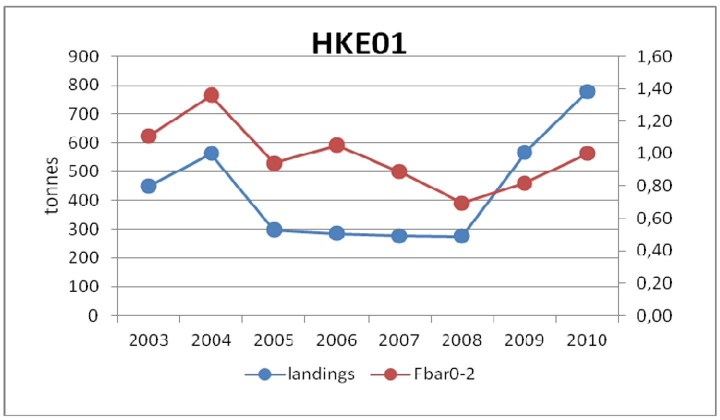


Fig. 6.1.4.1.3.3 Evolution of landings and fishing mortality (F_{bar} 0-2) during 2003-2010.

The evolution of landings and F_{bar} 0-2 was similar during 2003-2010.

6.1.5 Long term prediction

6.1.5.1 Justification

The yield per recruit method was used for the estimation of $F_{0.1}$ and F_{max}.

6.1.5.2 Input parameters

Table 6.1.5.2.1. Input parameters to the yield per recruit analysis.

age group	stock weight	catch weight	maturity	F	M
0	0,030	0,030	0	0,09	1,24
1	0,130	0,130	0,15	1,49	0,61
2	0,473	0,473	0,82	1,42	0,48
3	1,066	1,066	0,98	1,94	0,43
4	1,836	1,836	1	1,27	0,40
5+	2,542	2,542	1	1,27	0,38

6.1.5.3 Results

The reference F used is F_{bar} 0-2 over 2003-2010 (F_{curr}= 0.98). F_{bar} 0-2 was chosen because age classes 0-2 are the most abundant in landings. Results were the following: F_{ref} = 0.98; $F_{0.1}$ = 0.16; F_{max} = 0.25. These results show a clear situation of overfishing.

Since age 1 was the smallest age fully recruited, the analyses was also run considering Fref= F_{bar} 1-2 over 2003-2010= 1.37. Results were the following: F_{ref} = 1.37; $F_{0.1}$ = 0.22; F_{max} = 0.34.

Based on pseudocohort analysis (VIT), using 2008 and 2009 data, a reference point for this stock was proposed in EWG11-05 (Ponza, May 2011): $F_{0.1}$ (mean) ≤ 0.21.

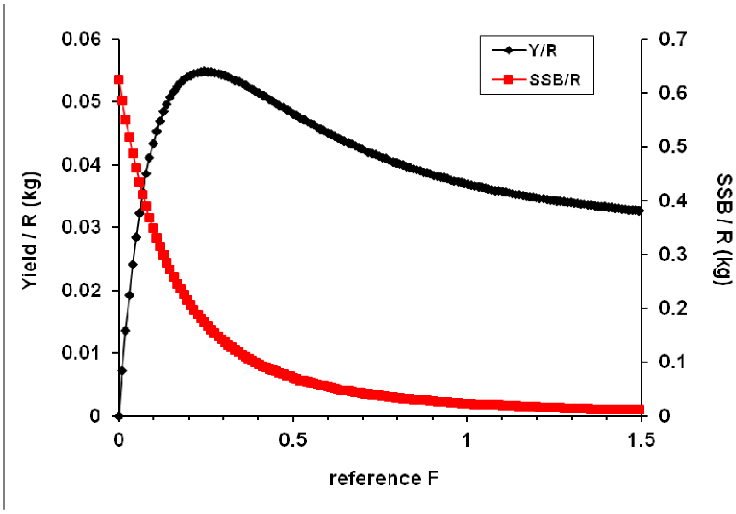


Fig. 6.1.5.3.1.1 YpR and SSB/R analyses for hake in GSA 01.

6.1.6 Data quality

The last submission provides data by gear. The values of the new data series 2002-2010 are higher than those previously submitted and include gears other than OTM: GNS, LLS for the whole period and GTR only for 2009 and 2010. The new data series was used for the analyses.

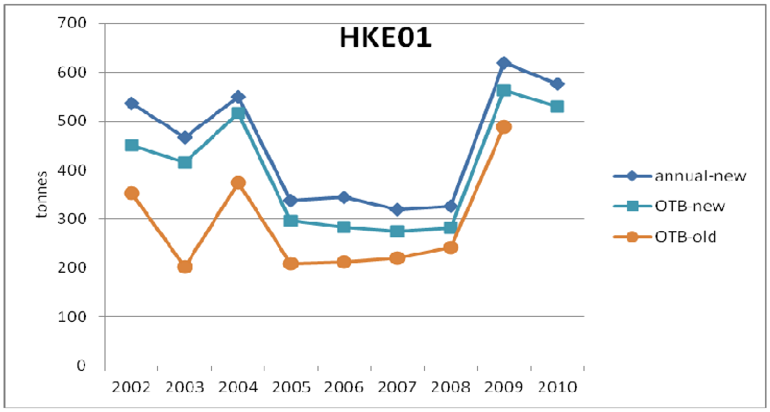


Fig. 6.1.6.1 Different DCF landings data as submitted in 2010 and 2009.

The last data call requested data to be sent on a quarterly basis. Overlapping of fleet segments in the fishing effort data was detected, which prevented calculating directly the annual values from the quarterly values.

The annual landings submitted in the DCF and calculated from the annual sizes are quite coincidental, with the exception of 2010.

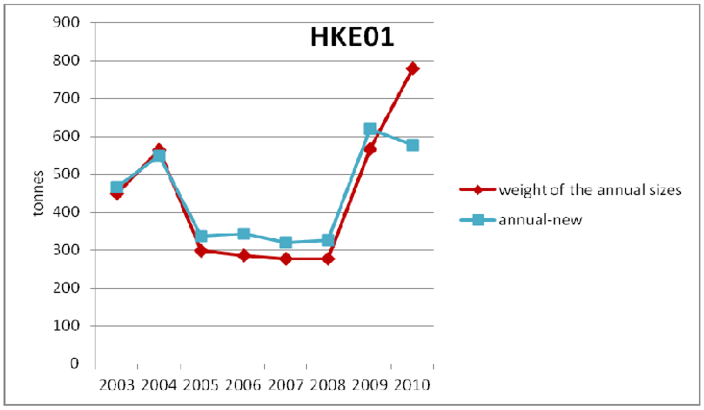


Fig. 6.1.6.2 Sum of products check of the catch at age and mean weight at age DCF data.

6.1.7 Scientific advice

6.1.7.1 Short term considerations

6.1.7.1.1 State of the spawning stock size

The time series is short (2003-2010). Although with regard to the previous years, SSB increased in 2009 and 2010, no baseline for comparison of the current values against historic SSB is available. Nevertheless, considering a two- years lag for relating recruitment in year(t) with the SSB in year (t+2), although the time series is short, it seems that low recruitment in year t is followed by low SSB two years later, and that an inter-annual increase in recruitment is reflected in an SSB increase two years later. The time-lag of two years was chosen considering the age of maturity of the species. Since no precautionary level for the stock of hake in GSA 01 was proposed, EWG 11-12 cannot evaluate the stock status in relation to the precautionary approach.

6.1.7.1.2 State of recruitment

Exploitation of hake in GSA01 is based on age classes 0 and 1 and, hence, this fishery is highly dependent on recruitment. Over the period 2003-2010 the recruitment displayed marked inter-annual variations, with no apparent trend.

6.1.7.1.3 State of exploitation

EWG 11-12 proposes $F_{0.1} \leq 0.21$ as limit management reference point consistent with high long term yields (F_{MSY} proxy). The exploitation is based on age classes 0 and 1, with age 1 as smallest age fully recruited. By comparing $F_{0.1}$ and F_{max} against F_{ref}, taking as reference F_{bar} 0-2 over 2003-2010 and F_{bar} 1-2 over 2003-2010, EWG concluded that the resource is subject tot overfishing. The continued low abundance of adult fish in the surveyed population and landings indicate a very high exploitation rate far in excess of those achieving high yields and low risk of fisheries collapse.

6.2 Stock assessment of red mullet in GSA 01

EWG11-12 assessed this stock in 2011 and used as input DCF data on ages for two fleets bottom otter trawl and trammel net (OTB and GTR).

6.2.1 Stock identification and biological features

6.2.1.1 Stock Identification

Due to a lack of information about the structure of red mullet population in the western Mediterranean, this stock was assumed to be confined within the GSA 01 boundaries.

6.2.1.2 Growth

No information was documented during the EWG 11-12 meeting. The parameters selected for the analyses are the following: L_{inf}= 34.5, K= 0.34, t_0= -0.143 (Demestre *et al*. 1997). Length-weight relationships parameters are: a=0.00624, b=3.1597 (data source: DCF 2010 GSA 05).

6.2.1.3 Maturity

No new information was presented during EWG 11-12. Size at first maturity (50%) is around 13 cm TL and an age of 1.3 years old.

Age	0	1	2	3	4
Maturity	0.46	0.76	1	1	1

6.2.2 Fisheries

6.2.2.1 General description of fisheries

No updated information was available to EWG11-12. Red mullets are among the most important target species for the trawl fisheries but are also caught with set gears, in particular trammel-nets and gillnets (about 13% of the catches). From official data, the total trawl fleet of the geographical sub-area GSA 01 (Northern Alboran Sea region) is composed by about 170 boats: on average, 42 TRB, 60 GT and 197 HP (in 2007). Smaller vessels operate almost exclusively on the continental shelf (targeting red mullets, octopus, hake and sea breams), bigger vessels operate almost exclusively on the continental slope (targeting decapod crustaceans) and the remaining can operate indistinctly on the continental shelf and slope fishing grounds. Red mullet is intensively exploited during its recruitment from August to November.

6.2.2.2 Management regulations applicable in 2010 and 2011

No information was documented during EWG 11-12.

6.2.2.3 Catches

6.2.2.3.1 Landings

Landings data were reported to EWG11-12 through the Data collection regulation. The last submission provides landings for OTB and GTR for 2002-2010 and OTB length sizes for 2003-2010 and GTR length

sizes for 2009-2010. Total landings oscillated between 100 and 200 tons, with maximum landings in 2009 of around 225 tonnes.
Landings by otter trawlers represent around the 87% of the catch and they display an increasing trend. Landings by trammel nets represent 13% in average.

Table 6.2.2.3.1.1. Annual landings (in tons) by fishing technique as reported to EWG11-12 through the DCR data call.

	2002	2003	2004	2005	2006	2007	2008	2009	2010
GTR	14	20	15	18	19	18	17	23	14
OTB	81	119	113	94	105	130	136	202	186

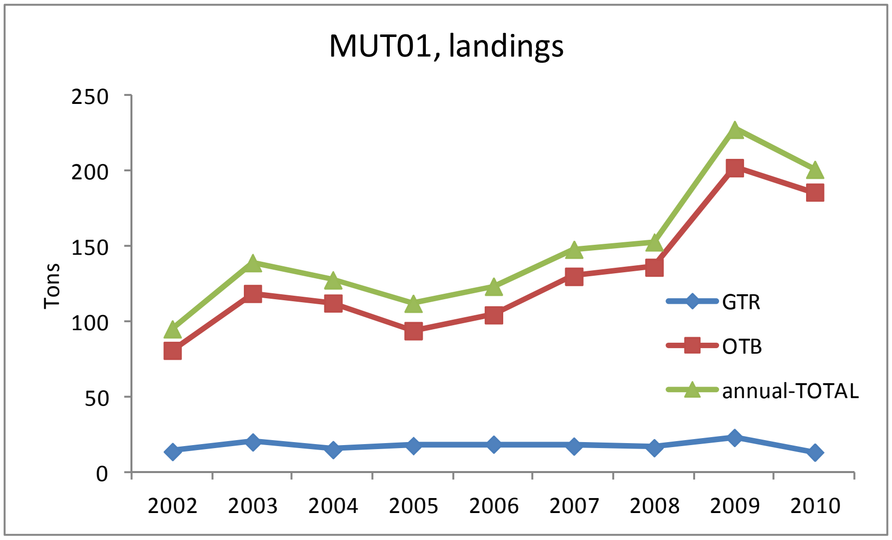


Fig. 6.2.2.3.1.1. Annual landings (in tons) by fishing technique as reported to EWG11-12 through the DCR data call.

6.2.2.3.2 Discards

There is information on discards for 2005, 2008, 2009 and 2010. The amount of discards reported is very low (0 t in 2005, 0.1 t in 2008, 1 t in 2009 and 0.1 t in 2010). There are no data on length or age for these discards.

6.2.2.4 Fishing effort

There is information on fishing effort for the period 2002-2010 for the GSA 01, but this information is not disaggregated by species. The trawl effort shows a decreasing trend in the analysed period while trammel net has an increasing trend. However, fishing effort for trammel nets represents only the 0.6% of the total effort.

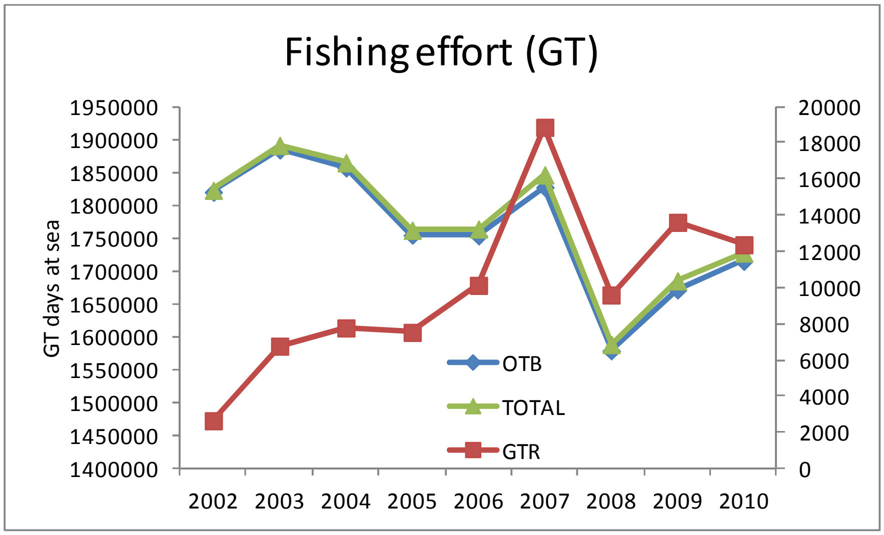


Fig. 6.2.2.3.3.1 Fishing effort (annual GT days at sea) of OTB and GTR fleets on the GSA 01.

6.2.3 Scientific surveys

6.2.3.1 MEDITS

6.2.3.1.1 Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 01 the following number of hauls was reported per depth stratum (Tab. 6.1.3.1.1.1).

Tab. 6.1.3.1.1.1. Number of hauls per year and depth stratum in GSA01, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA01_010-050	2	1	2	2	2	2	2	3	3	3	3	2	3	3	4	2	3
GSA01_050-100	5	4	5	5	5	7	6	4	6	10	7	7	6	6	6	7	6
GSA01_100-200	3	3	3	5	5	5	5	4	8	6	5	6	5	6	6	6	4
GSA01_200-500	7	9	11	10	7	11	12	10	11	11	13	11	11	11	11	11	6
GSA01_500-800	6	9	12	10	12	12	9	13	13	14	13	11	15	10	7	5	6

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$
$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$
Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum

Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.2.3.1.2 Geographical distribution patterns

No information was documented during EWG 11-12.

6.2.3.1.3 Trends in abundance and biomass

The estimated abundance and biomass indices derived from MEDITS data do not reveal any significant trends since 1994, and fluctuations from 2004 with wide boundaries. Figure 6.2.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 01.

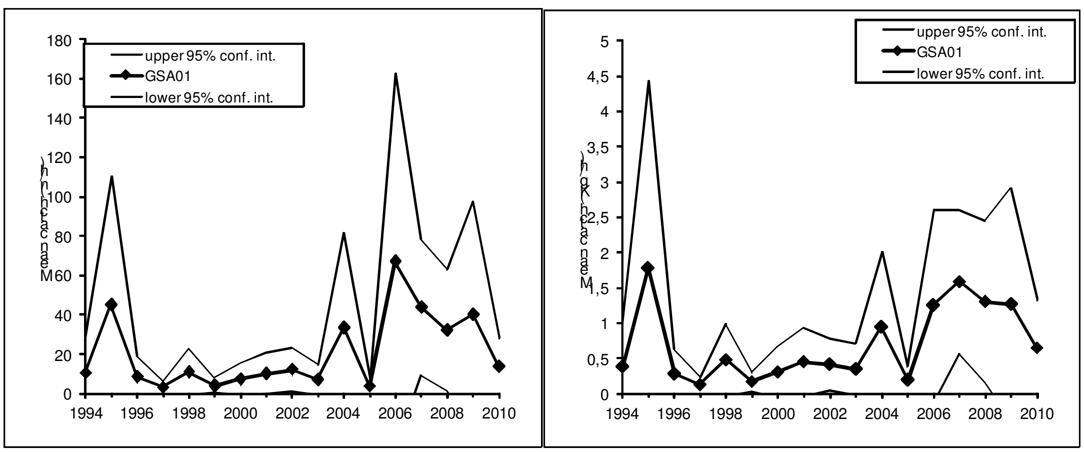


Fig. 6.2.3.1.3.1 Abundance and biomass indices of red mullet in GSA 01.

6.2.3.1.4 Trends in abundance by length or age

The following Figs. 6.2.3.1.4.1 and 2 display the stratified abundance indices of GSA 01 in 1994-2001 and 2002-2010 by length.

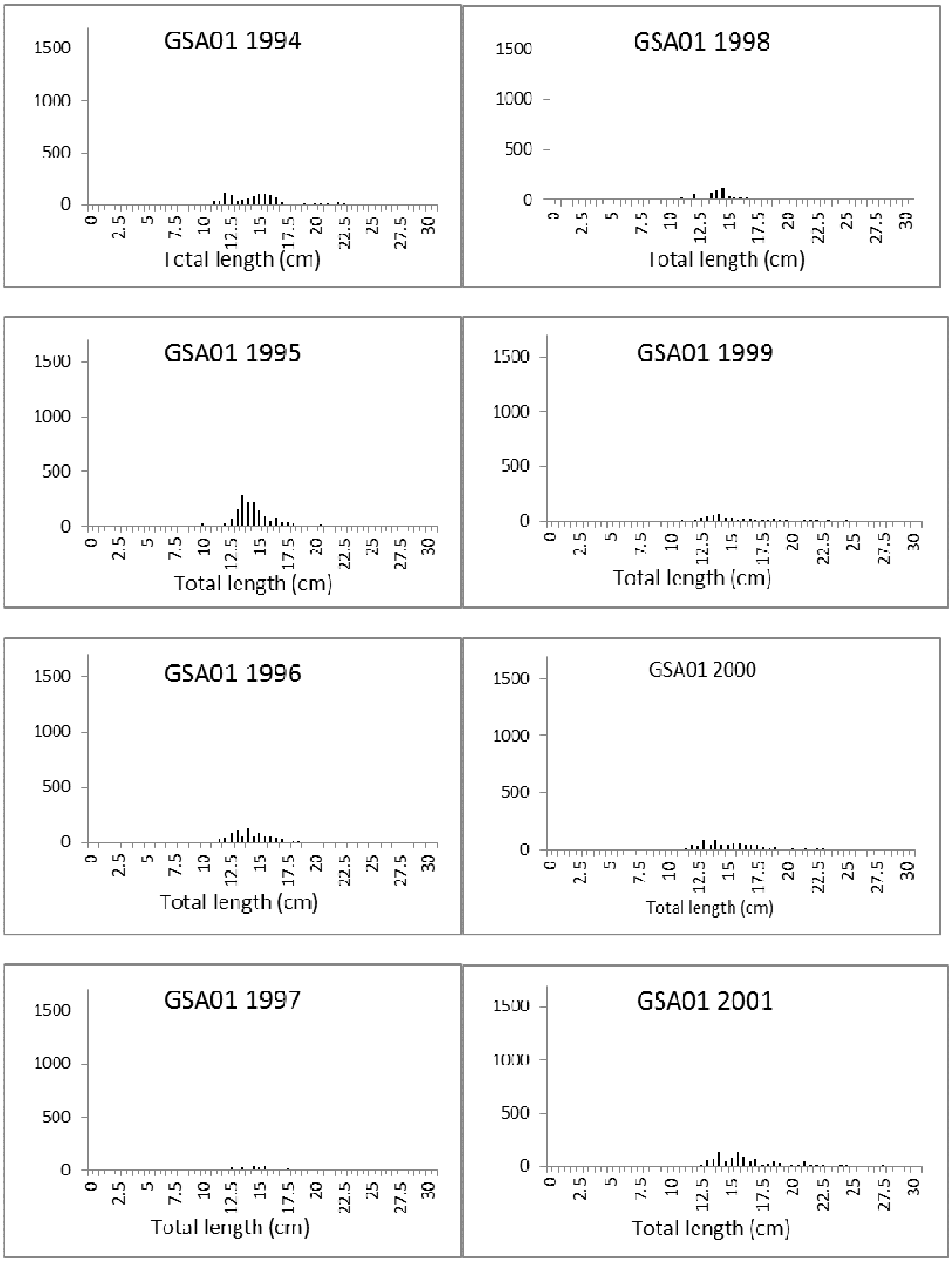
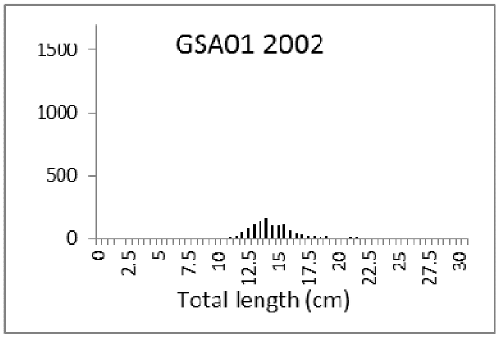
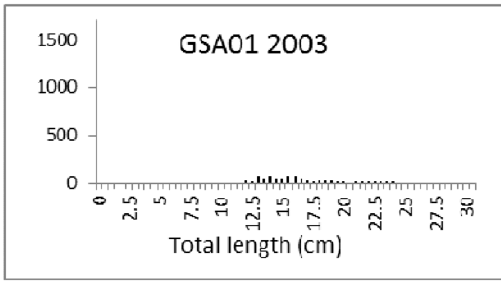
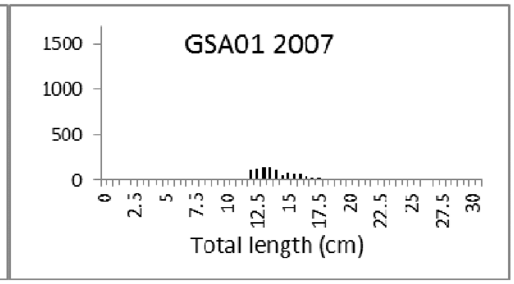
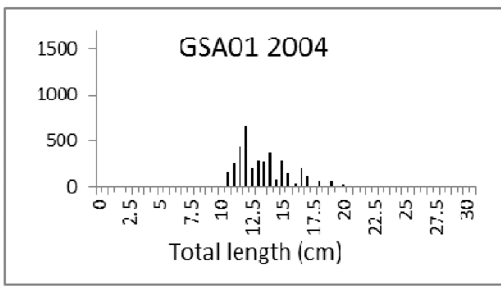


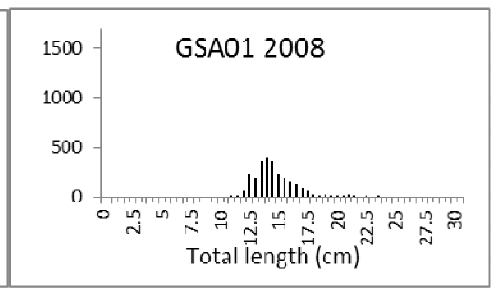
Fig. 6.2.3.1.4.1 Stratified abundance indices by size, 1994-2001.

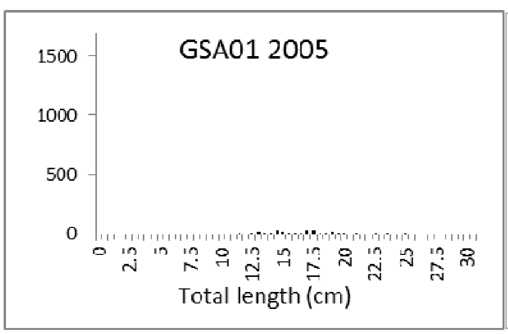

GSA01 2002
1500
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)

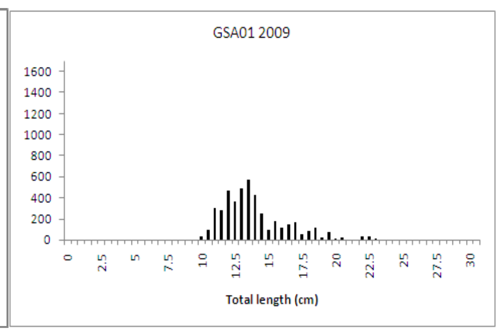

GSA01 2003
1500
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA01 2007
1500
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA01 2004
1500
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA01 2008
1500
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA01 2005
1500
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA01 2009
1600
1400
1200
1000
800
600
400
200
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)

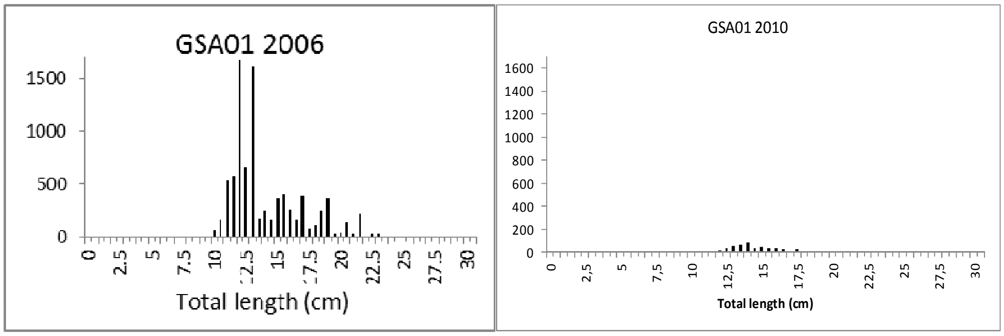


Fig. 6.2.3.1.4.2 Stratified abundance indices by size, 2002-2010.

6.2.3.1.5 Trends in growth

No information was documented during EWG 11-12 meeting.

6.2.3.1.6 Trends in maturity

No information was documented during EWG 11-12 meeting.

6.2.4 Assessments of historic stock parameters

6.2.4.1 Method 1: XSA

6.2.4.1.1 Justification

The last assessment of this stock was conducted in EWG 11-05 meeting (Abella et al., 2011). The stock was assessed through pseudo-cohort analysis using as input the 2008 and 2009 pseudocohorts. Furthermore, a yield per recruit (Y/R) analysis was also performed. For both analyses, the VIT software (Lleonart and Salat 1992) was used. During EWG 11-12, the methodology used was XSA, using as input 2003 to 2010 age data (DCF data). This is the first time that an XSA analysis is performed for the assessment of red mullet in GSA01.

6.2.4.1.2 Input parameters

Input data were taken from DCF: total landings (OTB and GTR) for the period 2003-2010, combined with the available annual length frequencies by gear.

The OTB length frequency distributions used for the present assessment showed similar size range with the modal values very variable depending on the year (around 15 cm in 2003; around 11 cm in 2010).

Since GTR length frequency data are available only for 2009-2010, we have assumed the same GTR length frequency distribution for the period 2003-2008 as a mean of length frequencies of 2009-2010, taking in account the relative importance of GTR catches in the different years.

A combined length frequency (OTB and GTR) data has been used for the analyses.

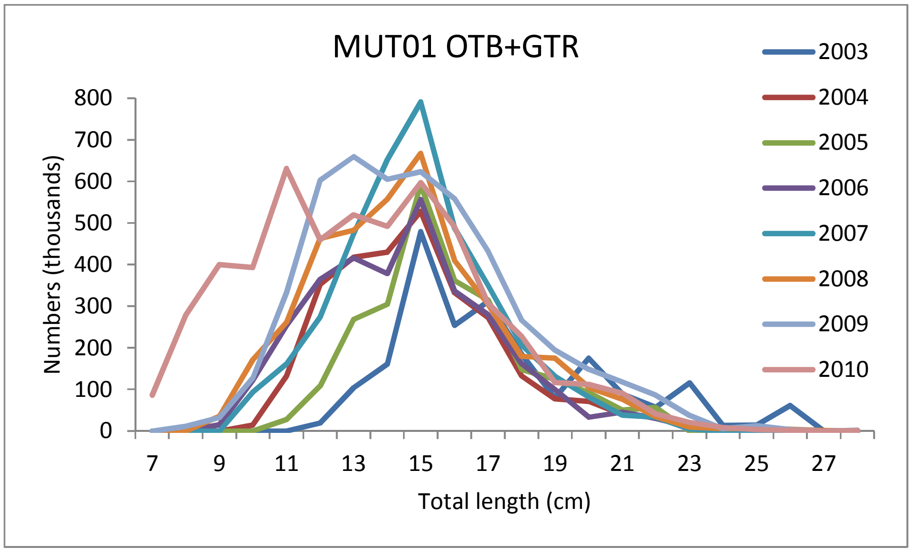


Fig. 6.2.4.1.2.1. OTB and GTR length frequencies for the period 2003-2010.

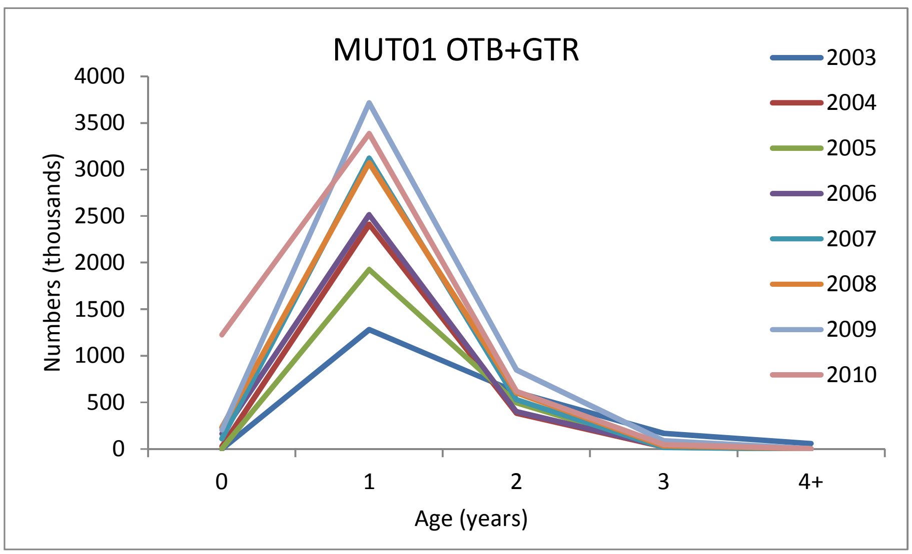


Fig. 6.2.4.1.2.2 Length frequencies for the period 2003-2010.

The annual length distributions of the landings were transformed to ages using L2Age4 software. Age class 1 was the smallest age fully recruited and age classes 1 and 2 represented more than 90% of the catch in number over the period 2003-2010.

The biological parameters used were the following: (Linf=34.5, K=0.34, t0=-0.143; Demestre et al. (1997)); and the length-weight relationships parameters from DCF 2010 in GSA05 (a=0.00624, b=3.1597). The set of growth parameters is different from that used in the last assessment (2011, EWG 11-05; Linf=29, K=0.6, to=-0.1) because the maximum landings sizes (28 cm) were very close to L_{inf}. The maturity ogive used was that proposed by the Spanish National Data Collection in GSA 01, compiled in SGMED_0803 report.

Tab. 6.2.4.1.2.1 XSA input data.

Catch numbers at age, Numbers*10**-3

AGE	2003	2004	2005	2006	2007	2008	2009	2010
0	0	28	3	164	110	234	207	1226
1	1281	2410	1928	2516	3120	3073	3714	3385
2	612	383	499	402	531	602	848	620
3	168	24	20	29	17	34	86	48
+gp	58	0	0	1	0	5	5	3
TOTALNUM	2118	2846	2450	3111	3779	3949	4860	5282
TONSLAND	122	98	100	103	131	135	177	148

Catch weights at age (kg)

AGE	2003	2004	2005	2006	2007	2008	2009	2010
0	0.000	0.012	0.014	0.011	0.011	0.011	0.010	0.008
1	0.039	0.032	0.036	0.031	0.033	0.031	0.031	0.029
2	0.079	0.076	0.077	0.074	0.073	0.076	0.078	0.077
3	0.138	0.126	0.117	0.138	0.123	0.139	0.135	0.135
+gp	0.222	0.227	0.226	0.234	0.226	0.225	0.227	0.229

Natural Mortality (M) at age

AGE	2003	2004	2005	2006	2007	2008	2009	2010
0	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03
1	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
2	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
+gp	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27

Medits numbers tune data: effort 100 hrs

AGE	2003	2004	2005	2006	2007	2008	2009	2010
0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
1	147.2	2540.5	41.9	5452.3	576.5	903.5	2604.4	198.3
2	511.9	1361.3	207.4	2947.0	571.5	1775.2	1739.6	356.3
3	45.8	11.7	24.7	377.9	25.2	50.7	91.4	30.3
4	1.4	.0	3.0	.0	2.9	.0	6.8	1.1
5	.0	.0	.0	.0	.5	.0	2.0	.0
6	.0	.0	.0	.0	.0	.0	.0	.0

6.2.4.1.3 Results

Table 6.2.4.1.3.1 shows lists of the fishing mortality at age as estimated by XSA.

Table 6.2.4.1.3.1. Stock numbers at age (thousands)

	Stock number at age (start of year)		Numbers*10**-3					
AGE	2003	2004	2005	2006	2007	2008	2009	2010
0	11492	9213	12170	15419	16082	17266	15735	26223
1	2427	4103	3272	4343	5407	5676	6024	5494
2	785	504	659	521	725	912	1118	829
3	266	39	33	46	30	65	137	76
+gp	87	0	0	2	0	10	7	4
TOTAL	15057	13859	16135	20330	22244	23929	23021	32626

The following Table 6.2.4.1.3.2 provides the summary of stock parameters as estimated by XSA.

Table 6.2.4.1.4.2 Summary of stock parameters as estimated by XSA.

	RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	SOPCOFAC	FBAR 0- 3	Fbar1-2
	Age 0							
2003	11492	194	173	122	0.7063	0.9098	1.2651	1.87245
2004	9213	256	174	98	0.5654	0.8965	1.2476	1.85995
2005	12170	310	201	100	0.4954	0.9051	1.23	1.84505
2006	15419	315	203	103	0.5042	0.9022	1.2893	1.91535
2007	16082	373	248	131	0.5303	0.905	1.1226	1.6846
2008	17266	404	273	135	0.4956	0.9043	0.911	1.34905
2009	15735	408	290	177	0.6096	0.9029	1.2972	1.92755
2010	26223	403	266	148	0.5563	0.9084	1.2813	1.86435
Arith. Mean	15450	333	229	127	.5579	1.2055		
Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)				

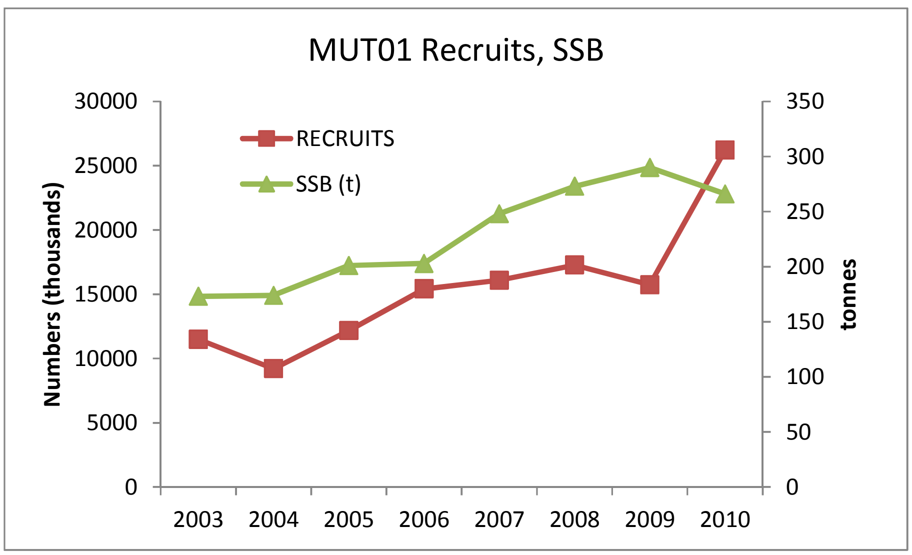


Fig. 6.2.4.1.3.1 Trends in spawning stock SSB and recruits at age 0.

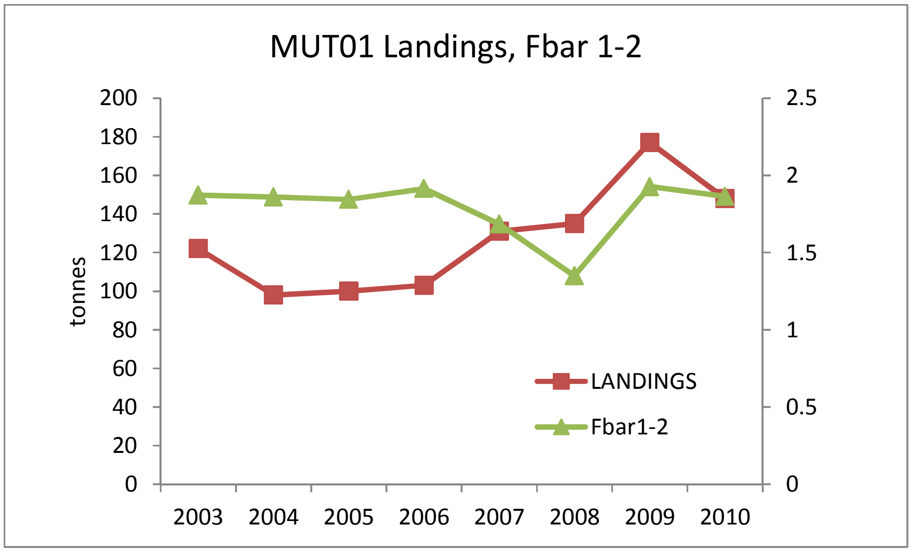


Fig. 6.2.4.1.3.2 Trends in landings and FBAR over ages 1-2.

SSB and recruitment show an increasing trend since 2003 to 2010.

Fishing mortality has maintained its values around 1.8 except in 2008 when F=1.4 (F_{bar} 1-2). The exploitation is concentrated mainly on age classes 1 and 2.

6.2.5 Long term prediction

6.2.5.1 Justification

A Y/R analysis has been conducted for the same period as that for the XSA analysis (2003-2010).

6.2.5.2 Input parameters

The length frequency data from 2008 and 2009 and the biological parameters were used as given in table 6.2.5.2.1

6.2.5.2.1. Input parameters to the yield per recruit analysis.

age group	stock weight	catch weight	maturity	F	M
0	0.010	0.010	0.46	0.02	1.03
1	0.033	0.033	0.76	1.33	0.47
2	0.076	0.076	1.00	2.25	0.35
3	0.131	0.131	1.00	1.22	0.30
4+	0.227	0.227	1.00	1.22	0.28

6.2.5.3 Results

EWG 11-12 estimated $F_{0.1}$ to 0.30. F_{ref} equals 1.79 and was computed as the mean F 1-2 over 2003-2010 period, F_{max} amounts to 0.54. (Figure 6.2.5.3.1). The curve of Y/R obtained for the MUT01 stock indicates overexploitation.

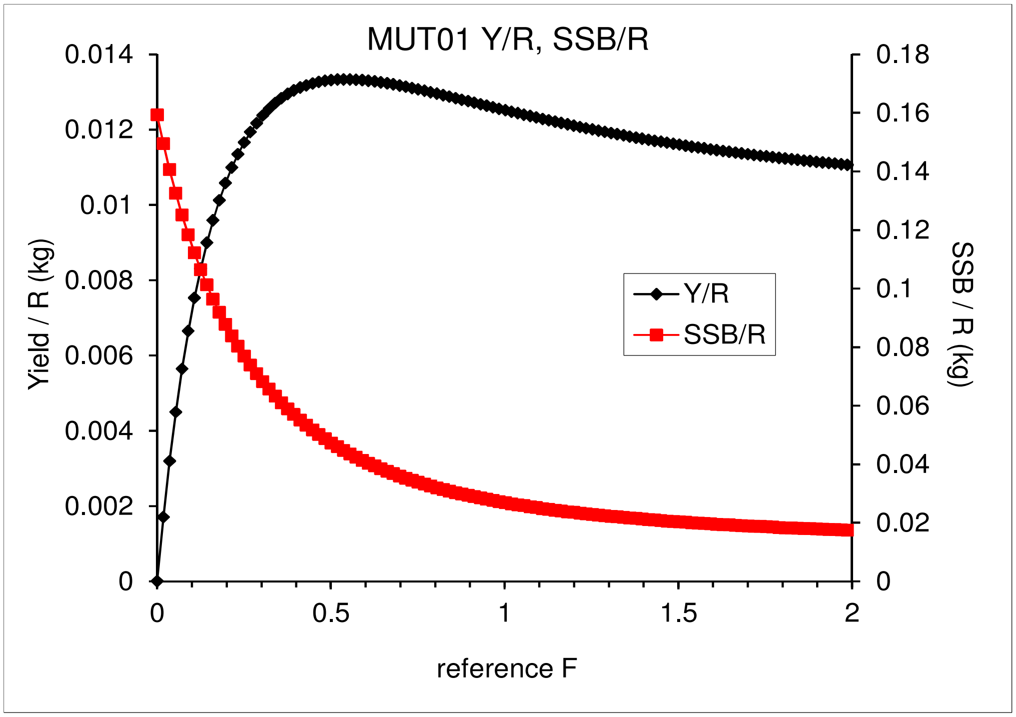


Fig. 6.2.5.3.1 Results of the Y/R analysis.

6.2.6 Data quality

The previous data submission provided only OTB data: landings 2002-2009 and sizes for 2003-2009. The last submission provides landings for OTB and GTR for 2002-2010 and OTB sizes for 2003-2010 and GTR sizes for 2009-2010. Landing values in the new series are higher (because GTR has been included). Further, the main differences between the OTB landings series 2002-2009 and 2002-2010 are for years 2003, 2008 and 2009 (Fig. 6.2.6.1). The annual landings submitted in the DCF (OTB and GTR) were higher than those calculated from the annual distribution of sizes.

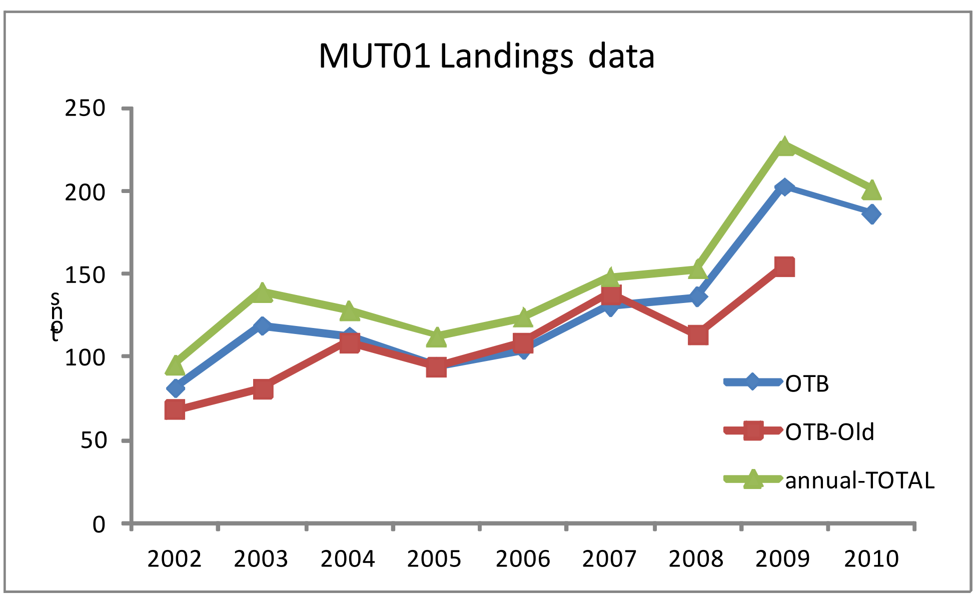
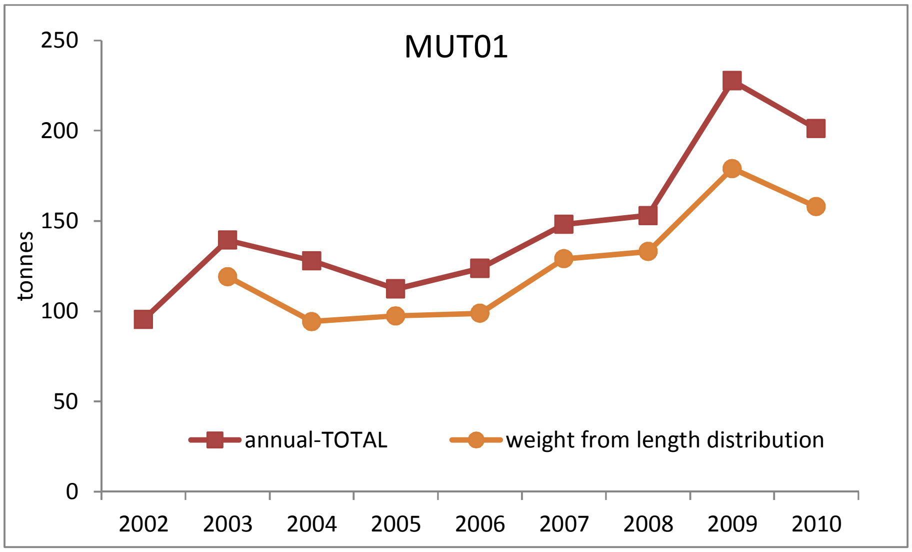


Figure 6.2.6.1. Comparaison of anuual landings data. Annual TOTAL (last submission data); OTB (last submission data); OTB-Old (previous data submission).



6.2.6.2. Landings data. Comparison between the landings values (t) and landings calculated from length distribution data (DCF data).

In MEDITS data there is probably a mistake: in 2005, one specimen was measured to be 36.5 cm

Information on sex ratio and length discards were not provided in the DCF. There is no detail of effort by species.

6.2.7 Scientific advice

6.2.7.1 Short term considerations

6.2.7.1.1 State of the stock size

EWG 11-12 is unable to provide any scientific advice of the state of the spawning stock in relation to proposed precautionary level given the state of the data and analyses. No reference points have been proposed. Over 2003-2010 the spawning stock biomass exhibited an increasing trend. Nevertheless, the time series is short and no baseline for comparison of the current values against historic SSB is available.

6.2.7.1.2 State of recruitment

EWG11-12 is unable to provide any scientific advice of the state of the recruitment given the state of the data and analyses. Over 2003-2010 the recruitment exhibited an increasing trend. Nevertheless, the time series is short and no baseline for comparison of the current values against historic SSB is available.

6.2.7.1.3 State of exploitation

EWG11-12 proposes : $F_{0.1} \leq 0.30$ (proxy of Fmsy) as a limit reference point consistent with higle long term yield and low risk of fisheries collapse. This reference point represents a revision of the reference point proposed in 2010 due to a change in assessment methods.

As the F_{bar}(1-2) in 2010 is estimated at F=1.79, the EWG 11-12 considers the stock of red mullet in GSA 01 to be subject to overfishing.

6.3 Stock assessment of European hake in GSA 06

6.3.1 Stock identification and biological features

6.3.1.1 Stock Identification

Due to a lack of information about the structure of hake population in the western Mediterranean, this stock was assumed to be confined within the GSA 06 boundaries.

6.3.1.2 Growth

The growth parameters used in the assessment were those coming from fast growth hypothesis and are L_{inf}= 106.0; k = 0.20, t_0= -0.0028 (Garcia Rodriguez & Esteban, 2002). These parameters are the same to those used in previous assessment (SGMED-09-02). The length-weight relationship parameters are a=0.0048 and b=3.12, also taken from Garcia Rodriguez & Esteban (2002).

6.3.1.3 Maturity

The maturity ogive was obtained through DCF official data for the period 2002- 2004, with size at first maturity (50 %, both sexes combined) at 32 cm TL. The maturity status was determined by macroscopic examination of the gonads during the reproductive period (no indication was provided on the months when sampling of the gonads was conducted).

Table 5.4.1.3.1 Maturity ogive of hake in GSA 6

age group	0	1	2	3	4	5	6	7	8	9
maturity	0	0.14	0.82	0.98	1	1	1	1	1	1

6.3.2 Fisheries

6.3.2.1 General description of fisheries

Hake (*Merluccius merluccius*) is one of the most important target species for the trawl fisheries carried out by around 600 vessels in the Northern Spain (GSA 06) with an average of 47 TRB, 58 GT and 297 HP, and distributed nearly proportionally (50%) between Catalonia and Valencia. In the last years (2002-2010), the annual landings of this species, which are mainly composed by juveniles living on the continental shelf, were around 4,000 tons in the whole GSA. It is also caught by around 50 longliners and 50 gillnetters. Trawl hake landings in GSA06 in 2009 were 3,754 tons (compared to 71 tons in GSA05 and 489 tons in GSA01).

6.3.2.2 Management regulations applicable in 2010 and 2011

The Spanish Administration acknowledged the poor status of the fishing resources in the Spanish Mediterranean and approved a plan for the conservation of the fishing resources in the Mediterranean, whose implementation is updated on a bi-annual basis (*Orden APA/254/2008, de 31 de enero, por la que se establece un Plan Integral de Gestión para la conservación de los recursos pesqueros en el Mediterráneo; Orden ARM/143/2010, de 25 de enero, por la que se establece un Plan Integral de Gestión para la conservación de los recursos pesqueros en el Mediterráneo*). This regulation, in line with EU regulations, includes the implementation of spatial and temporal closures along the Spanish coast, and limits the daily and weekly fishing effort to 12 hours per day five days a week. The plan affects purse-seining, bottom trawling, surface longlining and artisanal fishing and will end by 31 December 2012. By then, the number of vessels should have been reduced, at least, by 10%.

6.3.2.3 Catches

6.3.2.3.1 Landings

Because of the data quality problems reported in the section below, the absolute values (total annual landings) used in this assessment were those from the old data call, coming from the official data of the Autonomous governments. For the analysis of the relative landings by gear, values were taken from the new data call.

Fig. 6.3.2.3.1.1 shows the trend in reported hake landings taken by trawlers and the annual size distribution of the landings (minimum landing size of hake in the Mediterranean is set to 20 cm TL). The data were reported to EWG 11 12 through the Data Collection Framework. The total annual landings 2002- 2010 oscillated between 2,600 and 4,066 tons and showed a slight decreasing trend.

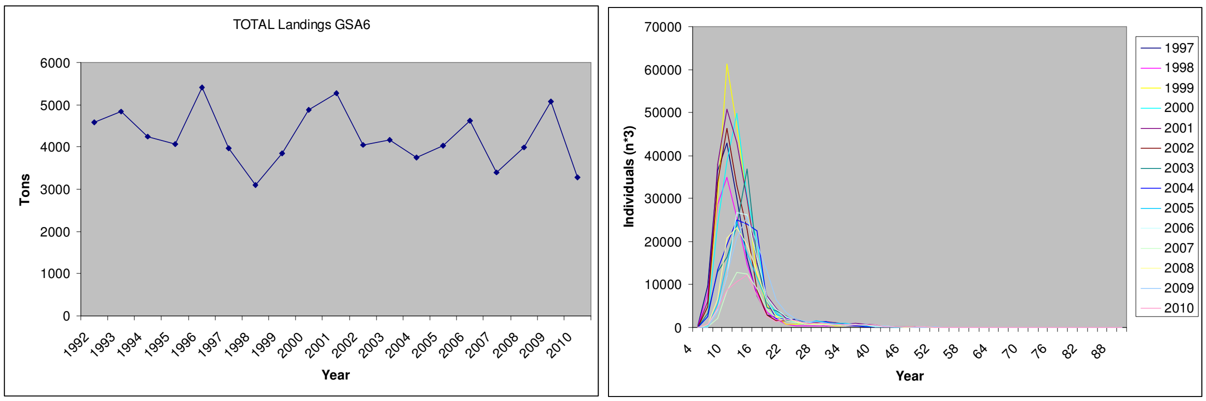


Fig. 6.3.2.3.1.1 Hake annual landings in GSA06, in weight (tons, left) and numbers (right).

Table 6.3.2.3.1.1 lists the reported total landings. Around 20% corresponded to longline and gillnet landings while the rest is taken by trawlers.

Tab. 6.3.2.3.1.1 Annual landings (t) in GSA 06, all gears combined

Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Hake Landings GSA6	3975	3105	3854	4873	5275	4048	4161	3760	4036	4627	3396	3985	5082	3278

6.3.2.3.2 Discards

Reported discards through the DCR data call to EWG 11 12 amount 90 kg in 2005; 416 kg in 2008, 309 kg in 2009 and 816 kg in 2010. No data on the discards size and/or age distributions were submitted.

6.3.2.4 Fishing effort

The trawl fishing effort data for GSA 06 was submitted by the Spanish authorities by quarter, area, gear and vessel length in the new data call. Fig 6.3.2.4.1 (left pannel) shows that overall, large trawlers (12-40m) are responsible for the largest part of the fishing effort devoted to hake in GSA 6 during the period 2002-2010: they account for the majority (97%) of the GT days at sea whereas small trawlers 0-12m length, longliners and gillnetters represent altogether the remaining 3%. In terms of the number of boats operating annually in the period 2002-2010, large trawlers constitute 75% of the fleet (Fig. 6.3.2.4.1 right pannel).

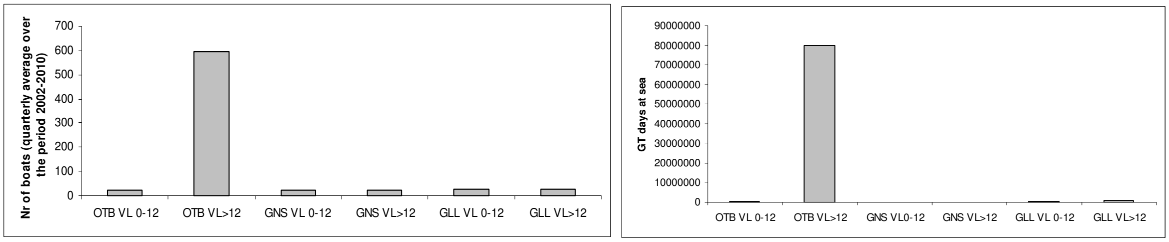


Fig 6.3.2.4.1. Total GT days at sea (left) and mean number of boats operating by year (right) in the period 2002-2010. OTB is bottom trawler, GNS is gillnet and LLS is longline (these are the gears targeting hake in GSA6). VL is the vessel length category.

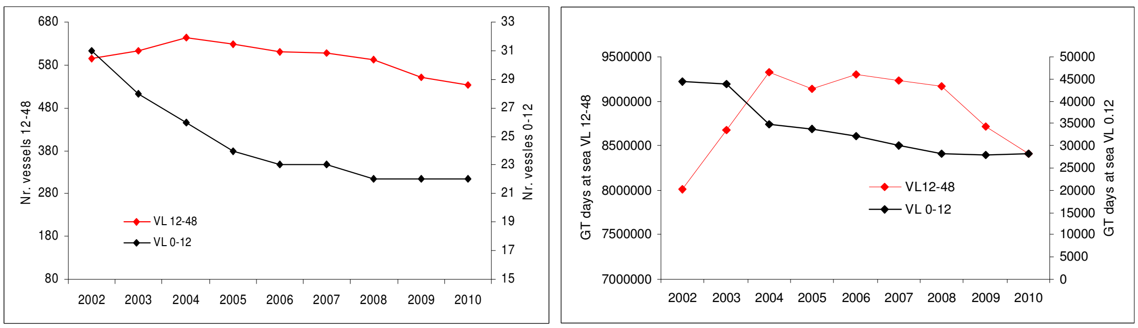


Fig Fig 6.3.2.4.2. Annual GT days at sea (right figure) and number of trawlers (left figure) in GSA 6, by different vessel length (VL) groups

For trawlers, the annual GT days at sea show a slight decreasing trend since 2004 for large vessels (12-40 m length) and a continuous decreasing trend since 2002 for small vessels (0-12 m length; see Fig. 6.3.2.4.2 left.

In contrast to trawlers, for gillnetters and longliners, both the annual GT days at sea and the annual number of boats show a strong increasing trend over the period 2002.2010 (fig 6.3.2.4.3 and fig 6.3.2.4.4). This is not in line with the recommendations of CGPM 2006, which recommended a reduction of fishing effort of gillnets and longliners because they are responsible of a non-negligible proportion (about 20%) of the total catch, and target mostly adult individuals.

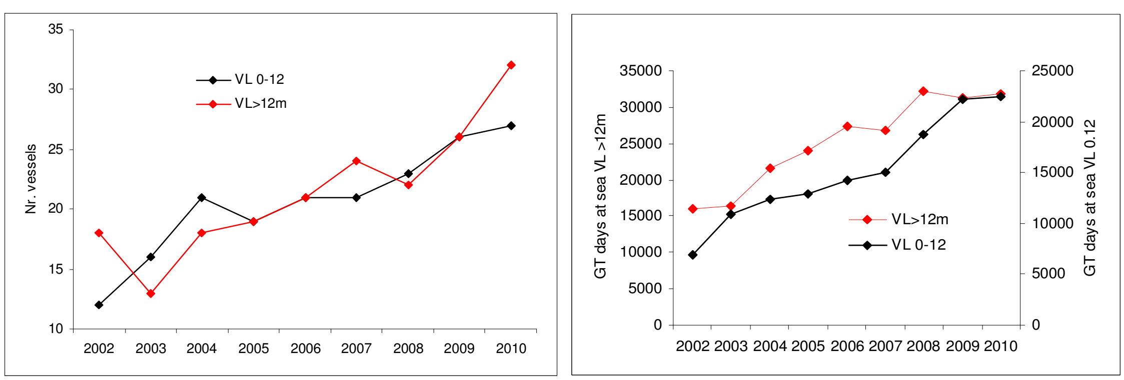
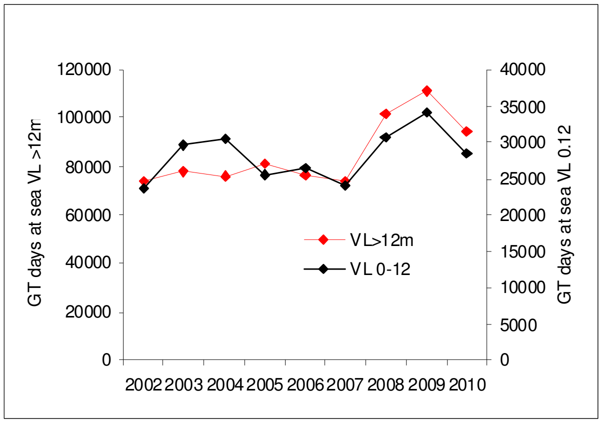


Fig 6.3.2.4.3. Annual GT days at sea (left figure) and number of gillnetting boats (right figure) in GSA 6, according to different vessel length (VL) groups



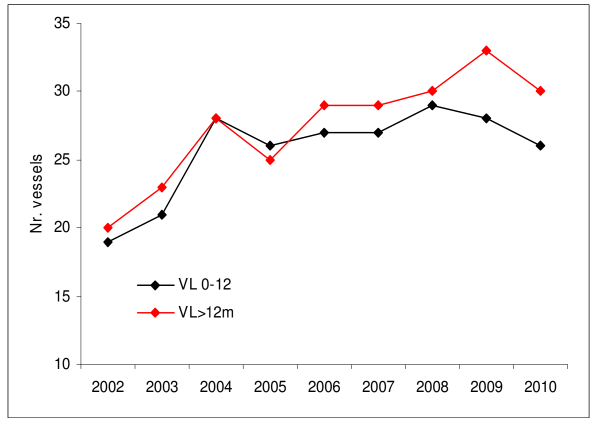


Fig 6.3.2.4.4. Annual GT days at sea (left figure) and number of long lining boats (right figure) in GSA 6, according to different vessel length (VL) groups

6.3.3 Scientific surveys

6.3.3.1 MEDITS

6.3.3.1.1 Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 06 the following number of hauls was reported per depth stratum (Tab. 6.3.3.1.1.1).

Tab 6.3.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-20010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA06_050-100	19	26	26	26	28	29	29	31	36	38	31	32	34	26	28	28	19
GSA06_100-200	11	17	17	15	13	17	18	20	20	21	17	18	19	15	17	20	13
GSA06_200-500	10	12	10	12	7	13	12	16	17	18	16	15	18	13	17	12	10
GSA06_500-800	6	8	9	7	4	9	6	8	7	11	11	8	10	10	11	9	6

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum

ni=number of valid hauls of the i-th stratum

n=number of hauls in the GSA

Yi=mean of the i-th stratum

Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.3.3.1.2 Geographical distribution patterns

No analyses were conducted during EWG 11-12.

6.3.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 06 was derived from the international survey MEDITS. Figure 6.3.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 06. Data indicate a general increasing trend in both abundance and biomass since 1996 till 2006; during 2007- 2010 values are low, especially regarding abundance, showing a weak recovery trend.

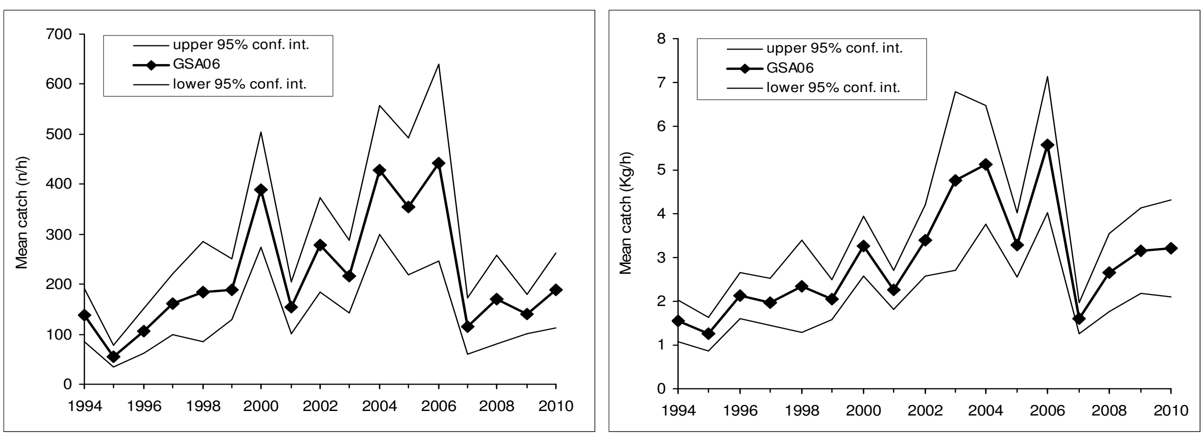


Fig. 6.3.3.1.3.1 Abundance and biomass indices of hake in GSA 06.

6.3.3.1.4 Trends in abundance by length or age

The following Fig. 6.3.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2001 and 2002-2010, respectively.

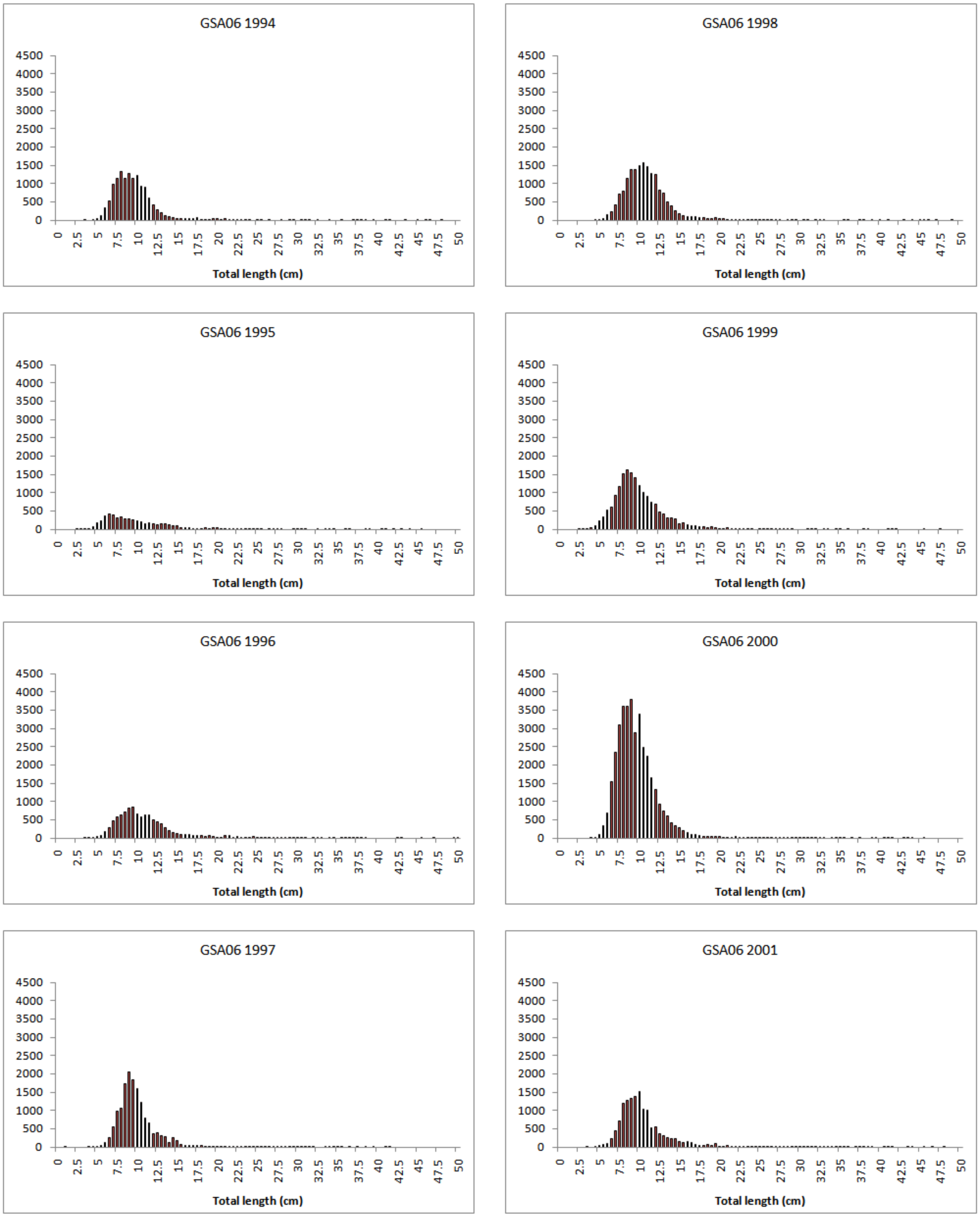


Fig. 6.3.3.1.4.1 Stratified abundance indices by size, 1994-2001.

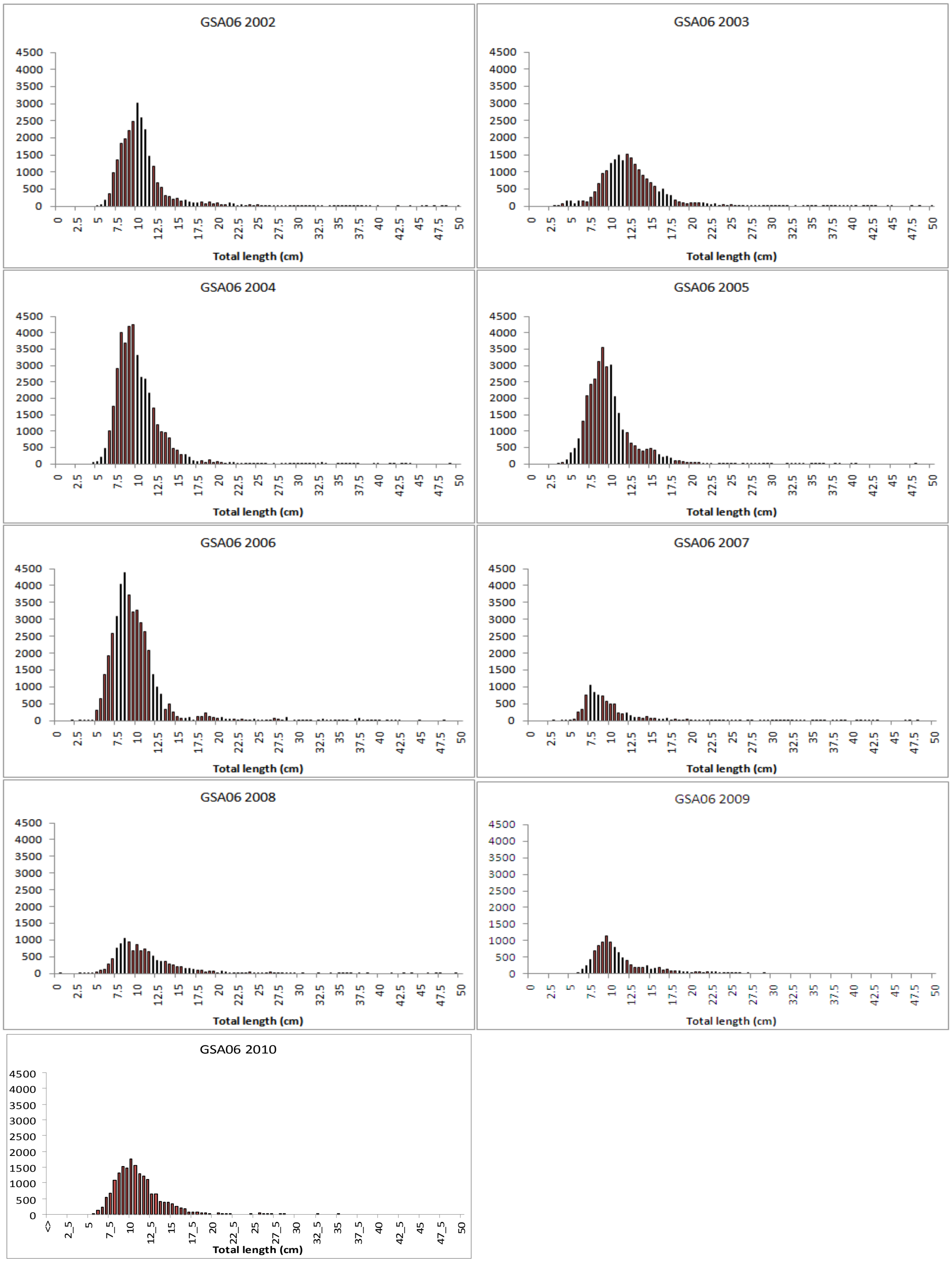


Fig. 6.3.3.1.4.2 Stratified abundance indices by size, 2002-2010.

6.3.3.1.5 Trends in growth

No information was been documented.

6.3.3.1.6 Trends in maturity

No analyses were conducted.

6.3.4 Assessments of historic stock parameters

6.3.4.1 Method 1: XSA

6.3.4.1.1 Justification

An XSA was performed calibrated with fishery independent survey abundance indices (MEDITS).

6.3.4.1.2 Input parameters

Input data were taken from DCF. No sizes composition for longliners was provided. The growth curve used was according to the fast growth hypothesis. The growth parameters are: L_{inf}: 106.0, K=0. 20, t_o: -0.0028. Numbers by age were estimated transforming the annual size distribution of the landings to ages using the L2Age4 software. The tuning parameters (MEDITS) were calculated by transforming the MEDITS length distributions to ages using L2Age4 software.

Table 6.3.4.1.2.1 lists the input parameters to the XSA, i.e. catch at age, weight at age, maturity at age, natural mortality at age and the tuning series at age (MEDITS). Natural mortality values (vector) were computed with PROBIOM. M of age group 0 is the mean over the first 12 months

Table 6.3.4.1.2.1. Input parameters to the XSA, i.e. catch at age, weight at age, maturity at age, natural mortality at age and the tuning series at age (MEDITS).

Hake GSA06   Catch at age.

Table 1 Catch numbers at age   Numbers*10**-3

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE														
0	144752	121774	188248	168787	187092	151066	111708	110160	78033	90173	47580	86745	90030	45796
1	10379	6261	9127	13628	15894	10043	12598	13083	13849	14579	9373	12139	22076	9944
2	1892	1789	1880	2505	3319	2117	2232	1327	2102	2443	2424	2329	2860	3016
3	315	196	306	158	216	317	290	214	175	384	275	197	384	465
4	68	38	36	33	17	14	35	16	6	21	29	66	43	60
5	20	11	4	2	1	0	1	4	1	4	0	1	3	1
6	27	1	0	5	0	0	0	0	0	0	2	0	0	0
7	2	0	5	0	0	0	0	0	0	0	1	0	0	0
8	3	0	0	0	0	0	0	0	0	0	1	0	0	0
+gp	0	3	0	0	0	0	0	0	9	9	0	0	0	0
0 TOTALNU	157457	130073	199605	185118	206540	163558	126865	124803	94174	107613	59687	101478	115397	59283
TONSLAN	3975	3105	3854	4873	5275	4048	4161	3760	4036	4627	3396	3985	5082	3278

Hake GSA06   Weight at age in kg.

Table 2 Catch weights at age (kg)

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE														
0	0.012	0.012	0.014	0.016	0.014	0.013	0.018	0.018	0.019	0.02	0.02	0.018	0.022	0.018
1	0.114	0.104	0.105	0.115	0.112	0.128	0.103	0.119	0.119	0.1	0.109	0.11	0.095	0.129
2	0.473	0.482	0.497	0.469	0.451	0.493	0.481	0.458	0.439	0.459	0.477	0.466	0.475	0.491
3	1.092	1.075	1.041	1.044	1.098	1.083	1.084	1.027	1.116	1.057	1.092	1.124	1.106	1.043
4	1.832	1.922	1.772	1.867	1.75	1.671	1.833	1.927	1.772	1.82	1.805	1.888	1.742	1.825
5	2.73	2.588	2.99	3.125	2.863	2.805	2.426	2.88	2.439	2.609	2.805	2.553	2.399	2.412
6	3.767	3.411	3.69	3.58	3.69	3.69	3.69	3.69	3.69	3.69	3.989	3.69	3.69	3.69
7	4.013	4.54	4.663	4.54	4.54	4.54	4.54	4.54	4.54	4.54	4.291	4.54	4.54	4.54
8	5.401	5.757	5.308	5.308	5.308	5.308	5.308	5.308	5.308	5.308	5.399	5.308	5.308	5.308
+gp	6.033	6.068	6.033	6.033	6.033	6.033	6.033	6.033	6.214	6.214	6.033	6.033	6.033	6.033
0 SOPCOF/	0.8906	0.9386	0.7795	0.8558	0.8554	0.8685	0.873	0.8524	0.9353	0.9455	0.9692	0.9196	0.8548	0.7829

age group	maturity	F	M
0	0	1.20	1.40
1	0.14	1.30	0.66
2	0.82	1.80	0.47
3	0.98	1.93	0.42
4	1	2.33	0.39
5	1	1.49	0.37
6	1	4.71	0.36
7	1	3.89	0.35
8	1	1.10	0.28
9	1	1.10	0.26

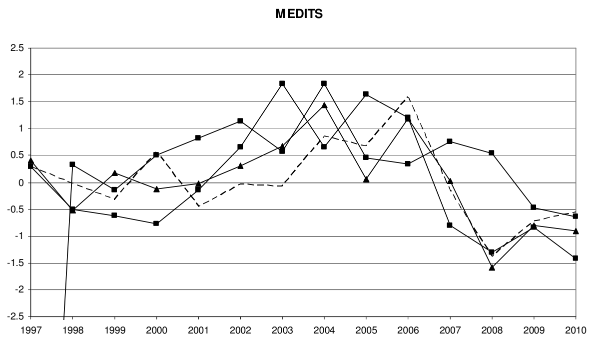
Tuning parameters (MEDITS)

MEDITS tunning

Age	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	464.105347	1438.485063	2189.267327	1898.729378	2030.541772	3842.738398	1597.420804	2100.730296	1988.928848	4156.010936	3366.377571	5964.976298	1561.104580	891.146911	1038.906378	1043.906380
1	35.066063	106.112938	98.328319	59.598918	65.670473	71.889278	86.656887	123.325211	195.494761	130.752391	227.058223	178.797720	61.285442	52.564344	72.213497	42.906380
2	2.175160	7.001999	8.544354	3.913560	5.942960	5.824430	9.060323	9.138997	11.947995	18.300223	8.214206	25.920525	6.779977	1.758745	4.686694	4.105550
3	0.413430	1.990000	0.000001	0.608145	0.464794	0.457894	0.721598	1.905497	0.723841	1.876449	0.500000	0.813012	1.500000	0.830000	0.503430	0.500000
4	0.210000	0.000001	2.496657	0.000001	0.240000	0.000001	0.420388	0.000001	0.314554	0.000001	0.000001	0.611249	0.120000	0.120000	0.200000	0.000010
5	0.000001	0.520000	3.333343	0.000001	0.000001	0.000001	0.130000	0.000001	0.170000	0.000001	0.000001	0.071194	0.000001	0.000001	0.000001	0.000010

6.3.4.1.3 Results including sensivity analyses

Hake XSA model diagnostics are shown in Fig. 6.3.4.1.3.1 and Table 6.3.4.1.3.1. No numeric blocks or trends in the log catchability residuals are recognizable.



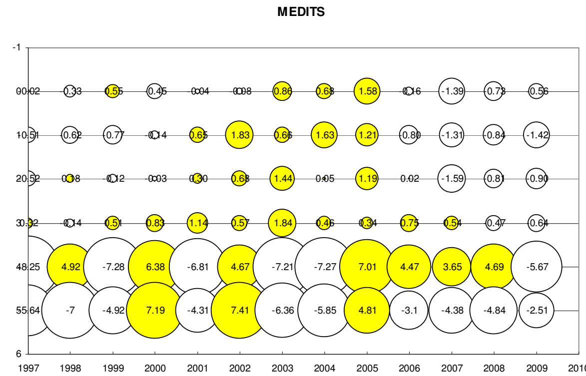


Fig. 6.3.4.1.3.1. Log catchability residual plots (XSA) for single fleets, MEDITS

Table 6.3.4.1.3.1. Hake XSA model diagnosis.

Fleet : MEDITS

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	0.29	-0.02	-0.33	0.55	-0.45	-0.04	-0.08	0.86	0.68	1.58	-0.16	-1.39	-0.73	-0.56
1	0.29	-0.51	-0.62	-0.77	-0.14	0.65	1.83	0.66	1.63	1.21	-0.8	-1.31	-0.84	-1.42
2	0.4	-0.52	0.18	-0.12	-0.03	0.3	0.68	1.44	0.05	1.19	0.02	-1.59	-0.81	-0.9
3	-13.39	0.32	-0.14	0.51	0.83	1.14	0.57	1.84	0.46	0.34	0.75	0.54	-0.47	-0.64
4	6.18	-8.25	4.92	-7.28	6.38	-6.81	4.67	-7.21	-7.27	7.01	4.47	3.65	4.69	-5.67
5	7.28	-5.64	-7	-4.92	7.19	-4.31	7.41	-6.36	-5.85	4.81	-3.1	-4.38	-4.84	-2.51

Age	2	3	4	5
Mean Log q	-9.9384	-10.3932	-13.6713	-13.6713
S.E(Log q)	0.8768	2.693	6.3416	5.6602

The tuning series appears to having no bit impact on terminal F estimiates given the high standard errors of mean log catchabilities estimated and listed above.

Table 6.3.4.1.3.2 Fishing mortality at age as estimated by XSA.

Table 8 Fishing mortality (F) at age

YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	FBAR **-*
AGE															
0	1.8095	1.3971	1.4474	1.3586	1.7092	1.4839	1.162	1.1077	0.8767	1.1555	0.644	0.723	1.1501	0.7055	0.8595
1	1.3318	1.0293	1.0896	1.155	1.5701	1.2263	1.7566	1.3798	1.353	1.4377	1.0729	1.1117	1.5382	1.183	1.2776
2	1.8646	1.5287	2.1228	2.1415	1.9848	1.7503	2.056	1.7277	1.5078	1.7411	2.0393	1.5095	1.528	1.6815	1.573
3	1.7085	1.5729	2.0189	2.0175	2.3993	1.8478	2.4683	2.4888	1.9488	2.313	1.3618	1.4421	1.6911	1.7314	1.6215
4	1.7352	1.3028	2.6299	2.8803	3.0339	2.0406	1.5852	1.5524	0.4904	4.2812	2.7368	2.7279	2.9613	2.6797	2.7896
5	1.1562	4.2736	0.435	1.6459	1.6141	0.1632	1.6826	0.9694	0.2835	0.8967	0.5735	2.3055	3.3029	1.5032	2.3705
6	2.5824	0.1499	1.8229	28.8909	0	0.5672	0.2599	0.5709	0.0504	0.0543	2.7657	21.278	1.7884	5.2244	9.4303
7	1.4037	0	4.9345	0	0	0.5219	3.7464	0.4774	4.1701	0	36.1683	3.0407	0	0	1.0136
8	1.7477	1.488	0	0	0	0	1.9943	0	1.4759	0	8.7064	0	0	0	0
+gp	1.7477	1.488	0	0	0	0	1.9943	0	1.4759	0	8.7064	0	0	0	
0 FBAR 0-3	1.679	1.382	1.670	1.668	1.916	1.577	1.861	1.676	1.422	1.662	1.280	1.197	1.477	1.325	**1.556**

Table 6.3.4.1.3.3 Stock numbers at age as estimated by XSA.

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	AGE															
	0	372035	347726	529020	488272	490999	419905	349408	353550	287272	282888	215387	362245	283150	194484	0
	1	19088	13186	18615	26931	27165	19239	20611	23662	25279	25879	19282	24487	38056	19405	20792
	2	2696	2750	2571	3417	4631	3084	3081	1942	3250	3566	3354	3600	4397	4461	3245
	3	448	288	412	212	277	439	370	272	238	497	432	301	549	658	573
	4	94	60	44	40	21	18	51	23	17	25	36	81	52	74	86
	5	34	13	12	2	2	1	2	8	4	8	0	2	4	2	4
	6	33	8	0	6	0	0	0	0	2	2	2	0	0	0	0
	7	2	2	5	0	0	0	0	0	0	2	2	0	0	0	0
	8	4	0	2	0	0	0	0	0	0	0	1	0	0	0	0
	+gp	0	4	0	0	0	0	0	0	12	0	0	0	0	0	0
0	TOTAL	394434	364037	550681	518882	523095	442687	373523	379458	316074	312867	238497	390717	326208	219086	24700

Table 6.3.4.1.3.4 Summary of stock parameters as estimated by XSA.

	RECR Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB 0	FBAR 0-3
1997	372035	7861	2015	3975	1.9729	1.6786
1998	347726	6935	1687	3105	1.8405	1.382
1999	529020	8742	1480	3854	2.6033	1.669675
2000	488272	10987	1783	4873	2.7332	1.66815
2001	490999	10566	2131	5275	2.475	1.91585
2002	419905	8644	1828	4048	2.2152	1.577075
2003	349408	9076	1760	4161	2.3643	1.860725
2004	353550	8881	1262	3760	2.9787	1.676
2005	287272	9616	1859	4036	2.1713	1.421575
2006	282888	9917	2186	4627	2.1169	1.661825
2007	215387	8306	2100	3396	1.6171	1.2795
2008	362245	10473	2074	3985	1.9216	1.196575
2009	283150	10807	2506	5082	2.0278	1.47685
2010	194484	7064	2326	3278	1.4089	1.32535
Arith. Mean	355453	9134	1928	4104	2.1748	1.56
0 Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)		

Fig. 6.3.4.1.3.2 Trends in spawning stock SSB and recruits at age 0.

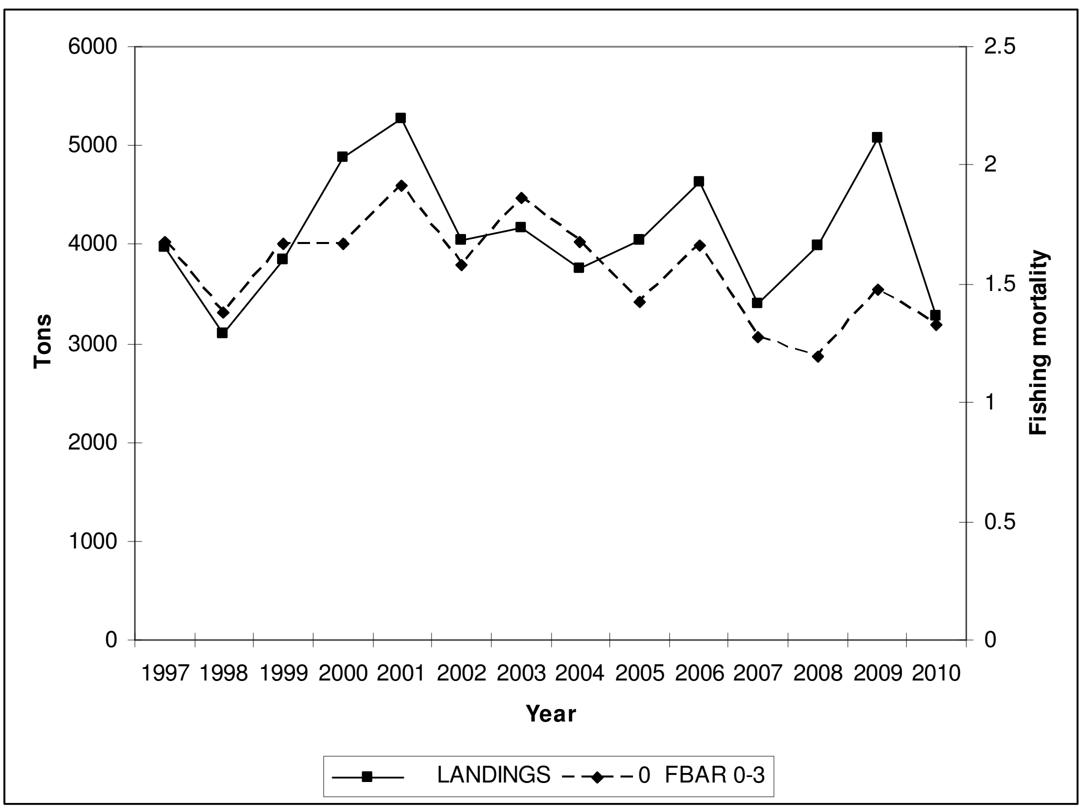


Fig. 6.3.4.1.3.3 Trends in landings and mean fishing mortality over ages 0-3.

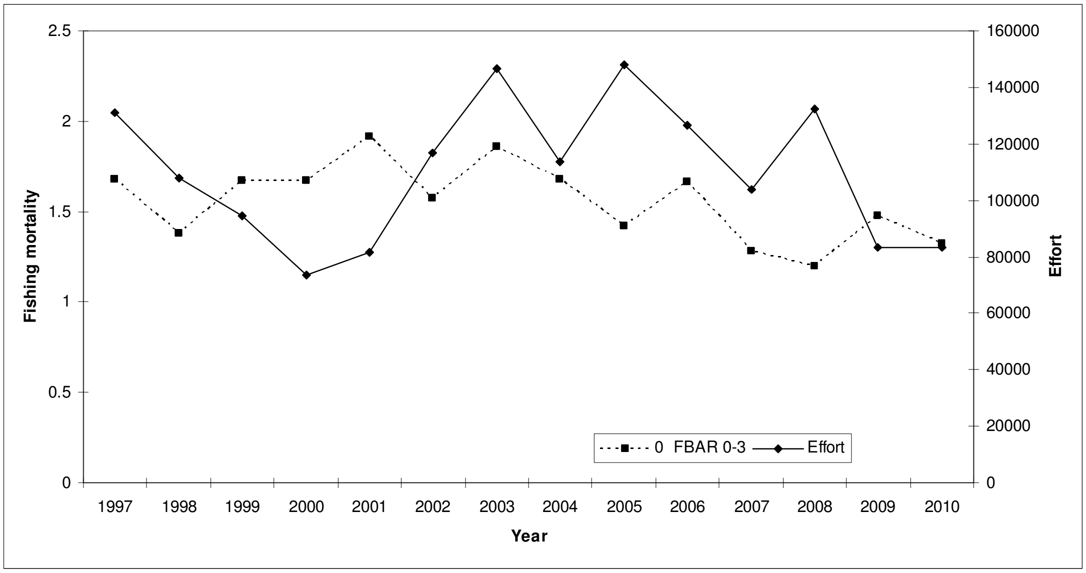


Fig. 6.3.4.1.3.4 Trends in effort and mean fishing mortality over ages 0-3.

Recruitment shows a continuous decreasing trend, with a little recovery in 2001, decreasing again thereafter. On the other hand, SSB shows a decreasing trend until 2005, recovering slightly since then to the levels of 1996 in 2010.

Landings and Fishing mortality (F_{bar} 0-3) shows a similar pattern, decreasing slight but continuously along the time series analyzed. The exploitation is concentrated on very young age classes, mainly 0, 1 and 2.

6.3.5 Long term prediction

6.3.5.1 Justification

The yield per recruit Y/R was used for the estimation of $F_{0.1}$ and F_{max}.

6.3.5.2 Input parameters

F_{ref} is F_{bar} 0-3 over 1995-2010. All input parameters are listed in Table 5.4.5.2.1 below.

Table 6.3.5.2.1 YpR inputs.

age group	stock weight	catch weight	maturity	F	M
0	0.019	0.019	0	1.195	1.40
1	0.111	0.111	0.14	1.303	0.66
2	0.477	0.477	0.82	1.799	0.47
3	1.091	1.091	0.98	1.929	0.42
4	1.818	1.818	1	2.331	0.39
5	2.455	2.455	1	1.486	0.37
6	3.690	3.690	1	4.715	0.36
7	4.540	4.540	1	3.890	0.35
8	5.308	5.308	1	1.101	0.28
9	6.033	6.033	1	1.101	0.26

6.3.5.3 Results

Results are shown in Fig. 6.3.5.3.1: $F_{ref} = 1.5$; $F_{0.1} = 0.105$; $F_{max} = 0.18$

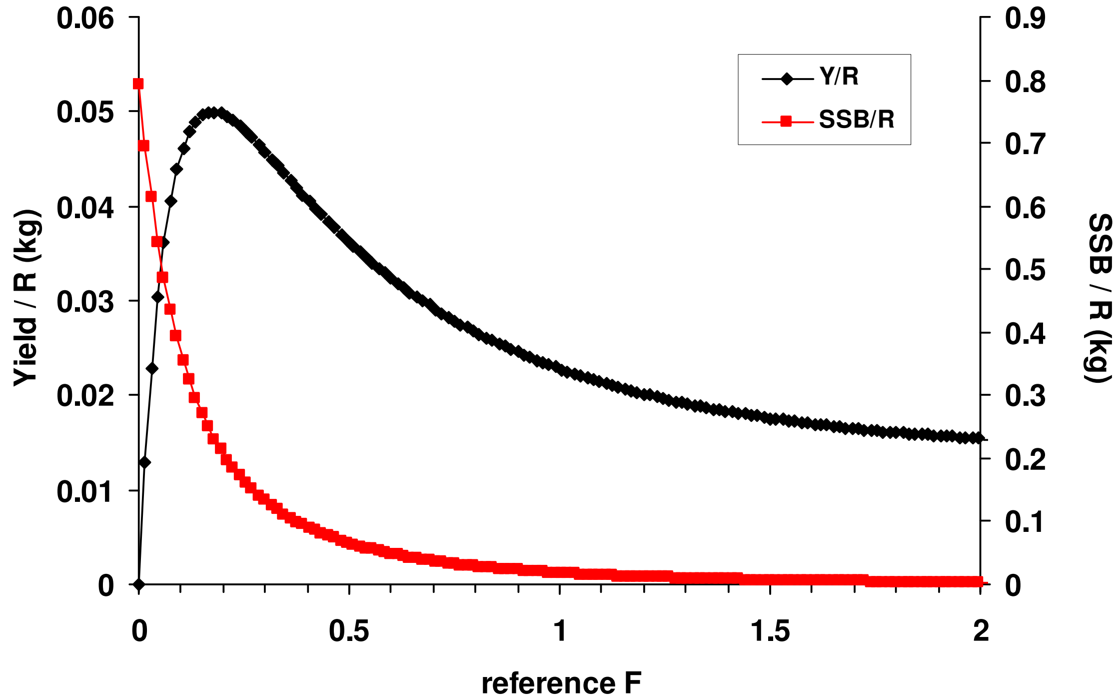


Fig. 6.3.5.3.1 Results of the Y/R analysis, Y/R and SSB/R.

F_{bar} 0-3 was chosen because classes 0-3 are the most abundant in trawl landings. This is also the age range used in previous SGMED assessments

6.3.6 Data quality and availability

There are large differences when evaluating the relative difference between the hake GSA 06 landings data submitted in 2011 versus the landings submitted in 2010 for the period 2002-2009. Differences can be up to 77%. Although landings reported in 2011 include trawlers and gillnets (data submitted in 2010 included only trawlers), the large differences are attributed to the fact that landings reported in 2011 by quarter were from logbooks whereas landings reported in 2010 were from fish market statistics provided by different regional governments, being the later considered more accurate than the former.

Data format: length class interval: Until 2008 the length class interval was 2 cm, but in the last data call the class interval was given at 1 cm.

Data format: units: The unit of 2007 data on catch at length (numbers) is different from that used the other years.

Inconsistencies between files: The numbers of the annual landings and those of the annual landings by size are not coincidental in four (2002-2005) out of eight years of sampling (2002-2009). Largest inconsistency was observed for 2004 (40% of difference in numbers between the file of landings and the file of landings by size).

Data not available: No data available on the discards sizes or age distributions. No sizes information from longline landings.

Growth parameters: Growth parameters given for 2005-2007 and for 2008-2009 are the same but t_o is wrong. These growth parameters are also the same for hake in GSA05 (Linf= 85, k= 0.172, to= -0.177).

EWG 11-12 notes that the growth parameters given for the period 2002-2004 are very different from those given for the other periods (L_{inf}= 120, k= 0.124, to= -0.505) although in all cases the methodology used is otoliths reading. For the EWG 11 12 a different data set was used, based on length frequencies analysis assuming a fast grow hypothesis (L_{inf}= 106.0, k= 0.20, to= -0.0028).

Discards: According to the received data, discards are almost negligible.

MEDITS: Abundance and biomass indexes in 1998 should be checked, values are very low.

6.3.7 Scientific advice

6.3.7.1 Short term considerations

6.3.7.1.1 State of the spawning stock size

SSB is indicated to have increased since 2005. In the absence of a proposed precautionary reference point the EWG 11-12 is unable to fully evalutate the status of the stock size.

6.3.7.1.2 State of recruitment

Recruitment varied at a reduced level since 2005.

6.3.7.1.3 State of exploitation

By comparing $F_{0.1}$=0.1 and F_{max} against F_{ref}, taking as reference F_{bar} 0-3 (1.3) over 2007-2010, it can be concluded that the resource is subject to overexploitation.

The size composition of landings indicates that the exploitation is based on the very young age classes, mainly 0, 1 and 2 years old. The continued low abundance of adult fish in the surveyed population and landings indicate a very high exploitation pattern far in excess of those achieving high yields and low risk of fisheries collapse. It is worth noting that EWG 11-12 proposed F≤ 0.2 as a management target (SGMED 09-02 report), based on a revised stock assessment considering the fast growth hypothesis. Other management targets proposed by EWG were B_{pa}(spawning stock) ≥ 4,000t and B_{lim}(spawning stock) ≥ 2,200t. Current SSB is well below these targets (estimated SSB in 2010= 1,495 t).

STECF EWG 11-12 estimated also an increasing of SSB since 2005. The reproductive fraction of the population is caught by longline and gillnet. However, the increase of the gillnet and long lining effort over the period 2002-2010 may create a trouble for the spawning stock biomass considering that a major part of spawners are caught by these passive fishing gears. Thus, SGMED recommends a reduction in trawling fishing effort, along with a reduction of gillnet and long lining effort, in the context of a multi-annual management plan taking into account the multi-species landings of the trawl until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

Results of this assessment show lower values of F than those presented in the previous assessment of hake in GSA06 (SGMED09-02 report), where it was shown that F fluctuated around 1.6 (F_{bar} 02). The different input data used may explain the differences in the results of the assessments conducted during SGMED-09-02 and SGMED-10-02. The data series used in this assessment is much longer (1997-2010) than that used in the previous assessment (2002-2009). In any case, results are coincidental and hake is considered heavily over-exploited.

6.4 Stock assessment of red mullet in GSA 06

6.4.1 Stock identification and biological features

6.4.1.1 Stock Identification

Due to the lack of information about the structure of red mullet (*Mullus barbatus*) population in the western Mediterranean, this stock was assumed to be confined within the GSA 06 boundaries.

6.4.1.2 Growth

EWG 11-12 notes that no growth parameters were provided by DCF for red mullet in GSA 06. Taking into account the longest individuals measured in GSA 06, the set of parameters given for red mullet in the GFCM assessment 2010 (Fernández, 2010) were selected (L_{inf}: 34.5, K=0.34, t_0: -0.143). These growth parameters were calculated by Demestre et al. (1997) from the monthly size frequencies in different ports using modal progression with the Bhattacharya method and the software ELEFAN. Although in SGMED 09-01 it was agreed that a L_{inf} between 27 and 31 cm TL should be used for the estimation of M, the fact that individuals of 29 cm were observed in the catch, forced the adoption of the growth curve stated before. The length-weight relationship parameters are a=0.00624 and b=3.1597 (Fernandez, 2010).

6.4.1.3 Maturity

The maturity ogive was taken from GFCM (2008), with size at first maturity (50 %) at around 13 cm TL.

Tab. 6.4.1.3.1 Maturity ogive adopted from GFCM 2008.

Age class	0	1	2	3	4
Maturity ratio	0.46	0.76	0.88	0.93	1.00

6.4.2 Fisheries

6.4.2.1 General description of fisheries

According to the analysis carried out with data submitted in 2011, trawl accounts for the majority (98%) of the total landings of red mullet. The remaining 2% is taken by the gillnetters (small-scale or artisanal fisheries). Similar results were reported in other studies carried out in particular ports of the GSA 06 (Martín et al 1999). The exploitation of small individuals (recruitment fishery) by trawlers occurs since decades (stated already by Demestre *et al,* 1997). Spawning takes place in late spring and recruitment to the fishery occurs in autumn, when juveniles are heavily exploited by trawlers (Sánchez *et al*., 1995; Martín *et al*., 1999; Lloret and Lleonart, 2002).

6.4.2.2 Management regulations applicable in 2010 and 2011

The Spanish Adminsistration acknowledged the poor status of certain demersal species in the Spanish Mediterranean waters and approved a regulation for the conservation of the fishing resources (*ORDEN APA/254/2008, de 31 de enero, por la que se establece un Plan integral de gestión para la conservación de los recursos pesqueros en el Mediterráneo*). This regulation, in line with EU regulations, includes the implementation of spatial and temporal closures along the Spanish coast, and limits the daily and weekly fishing effort to 12 hours per day five days a week.

Minimum landing sizes: Spanish Real Decreto 560/1995 and EC regulation 1967/2006 defined 11 cm TL as minimum legal landed size for red mullet.

On the 31 of May of 2010, the derogation to the minimum mesh size of towed nets stated at the article 14.1 of the EC COUNCIL REGULATION (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea. Therefore, since 1st June 2010 the towed net used must be a square-meshed net of 40 mm at the cod-end or a diamond meshed net of 50 mm.

6.4.2.3 Catches

6.4.2.3.1 Landings

Because of the data quality problems reported in the section "Data quality and availability", the absolute values (total annual landings) were those from the old data call. For the analysis of the relative landings by gear, values were taken from the new data call. Fig. 6.4.2.3.1.1a and table 6.4.2.3.1.1 show the annual reported red mullet landings taken by trawlers and gillnetters altogether (data are pooled because 98% of the total landings are from trawlers and only the 2% left are from gillnets) according to data submitted in 2011 (the data were reported to STECF EWG 11-12 through the Data Collection Framework). The annual landings 2002-2010 oscillated between 300 and 1,700 tons. The 2010 annual landings (514 t) are the lowest recorded from the last five years. From 2002 to 2010, trawl landings were dominated by individuals of age 0 (juveniles) and 1 (small adults), both ages representing together 90% of the total landings. In contrast to this, gillnet landings were dominated by ages >1 (big adults, 62% of the total).

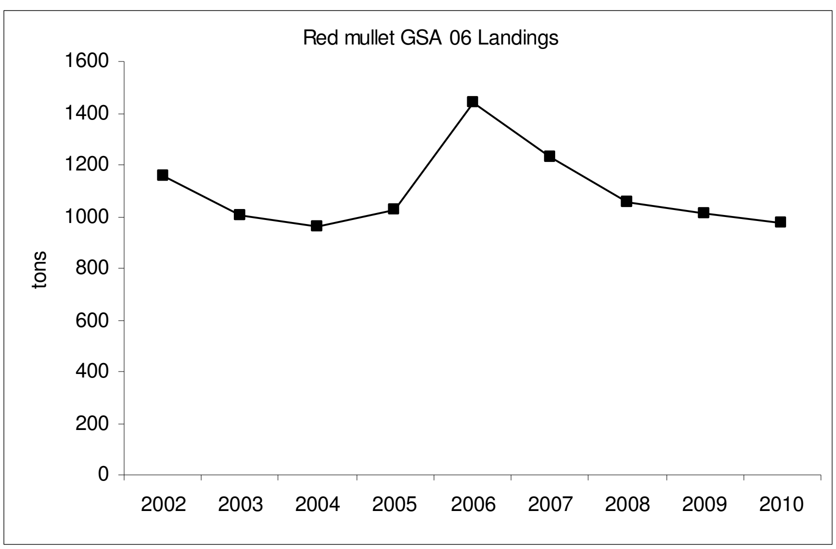


Fig. 6.4.2.3.1.1a Annual red mullet landings (t) by trawlers and GTR (both gears combined)

The percentage of the total annual catch taken in each quarter, by fishing gear, is shown in Fig. 6.4.2.3.1.1b. The highest proportion of landings of bottom trawl is taken in the fourth quarter (October-December) when recruits enter the fishing area. For gillnetters, the highest proportion of landings is taken in the fourth quarter (July-September).

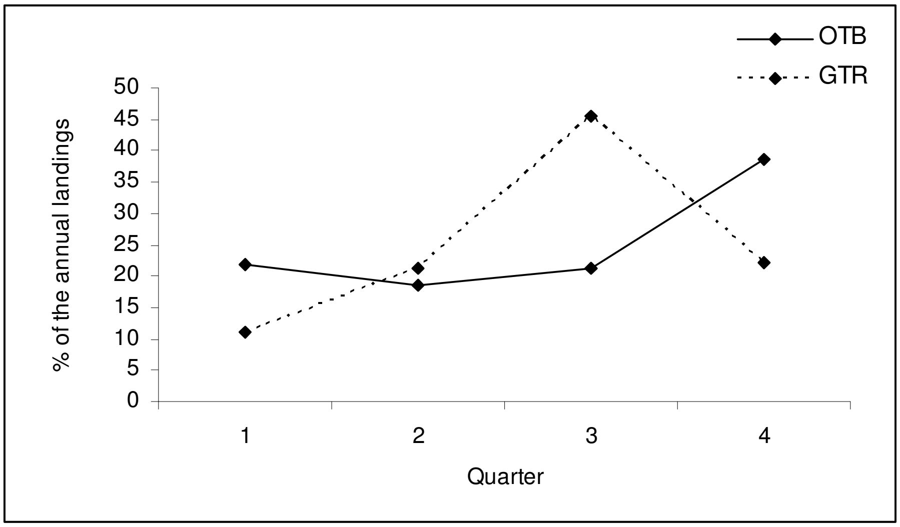
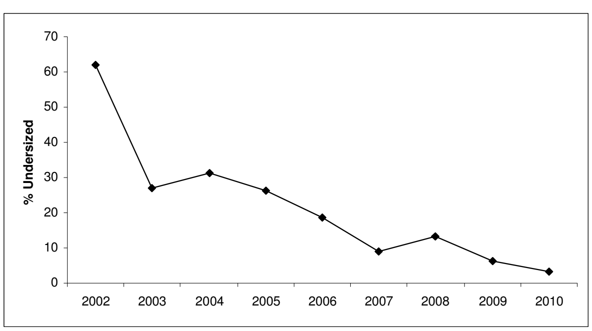


Fig. 6.4.2.3.1.1b Proportion of the total annual landings taken in each quarter, by fishing gear (OTB: bottom trawler, GTR: gillnet) according to data submitted in 2011

Tab. 6.4.2.3.1.1 Annual landings (t) by fishing technique (bottom otter trawl: OTB and gillnet GTR) in GSA 06 (according to data submitted in 2011).

SPECIES	AREA	COUNTRY	GEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010
MUT	6	ESP	OTB	303	1381	1662	569	819	713	549	509	503
MUT	6	ESP	GTR	2	19	30	8	7	8	10	12	11

The landings in numbers of red mullet in GSA 06 during the period 2002-2010 and the proportion of undersized individuals are shown in Fig. 5.18.2.3.1.2 (right and left figure respectively). The number of undersized red mullets (< 11 cm TL) steadily decreased from 2002 to 2010.



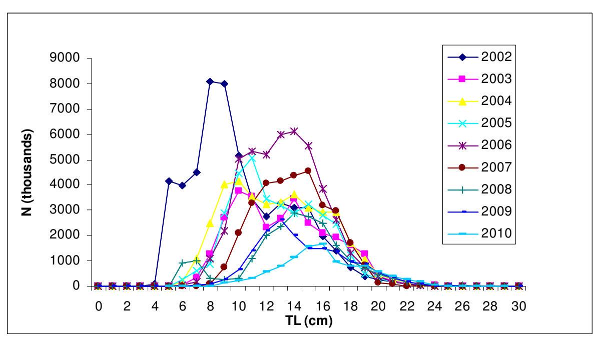


Figure 6.4.2.3.1.2. Landings in numbers of red mullet in GSA 06 during the period 2002-2010 (on the right) and the proportion of undersized individuals (on the left). Minimum legal size of red mullet = 11 cm TL

6.4.2.3.2 Discards

Reported discards in data call 2011 for the period 2008-2010 are negligible (less than 0.4 tons per year), representing about 2% of the landings. All these discards are from trawlers. Similar to this, the study carried out by Sánchez *et al.* (2007), showed very low discard rates in the Catalan Sea (northern part of GSA 06) for *Mullus barbatus.*

6.4.2.4 Fishing effort

The trawl fishing effort data for GSA 06 was submitted by the Spanish authorities by quarter, area, gear and vessel length in the new data call. Fig 6.4.2.4.1 (left side) shows that overall, large trawlers (12-40m) are responsible for the largest part of the fishing effort devoted to red mullet in GSA 6 during the period 2002-2010: they account for the majority (98%) of the GT days at sea whereas small trawlers (0-12m) and gillnetters represent altogether the remaining 2%. In terms of the number of boats operating annually in the period 2002-2010, 80% correspond to big trawlers (12-40m; Fig. 6.4.2.4.1 right).

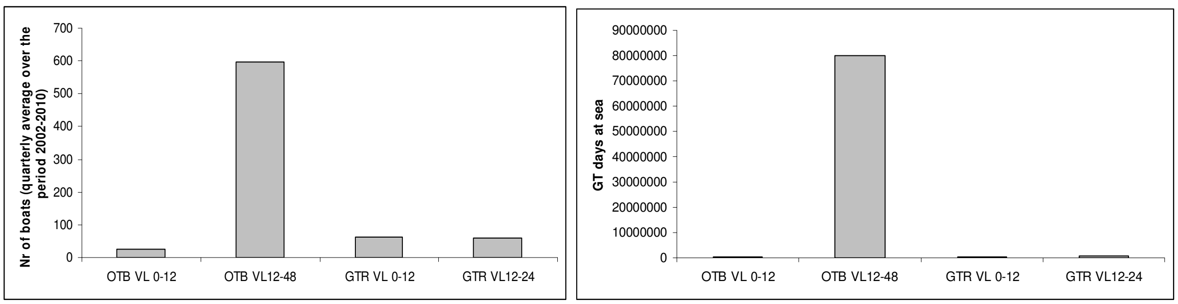


Fig 6.4.2.4.1. Total GT days at sea (left) and mean number of boats operating by year (right) in the period 2002-2010. OTB is bottom trawler, GTR is gillnet and VL is the vessel length category.

The annual GT days at sea show a slight decreasing trend since 2004 for large trawlers (12-40 m length) and a continuous decreasing trend since 2002 for small trawlers (0-12 m length; see Fig. 6.4.2.4.2 left). Regarding the number of trawlers (annual mean) a similar pattern is observed: the number of large trawlers (12-48m) shows a slight decrease from 2004 onwards (from about 650 to 550 vessels) whereas the number of small trawlers (0-12 m) decreased from 30 to 22.

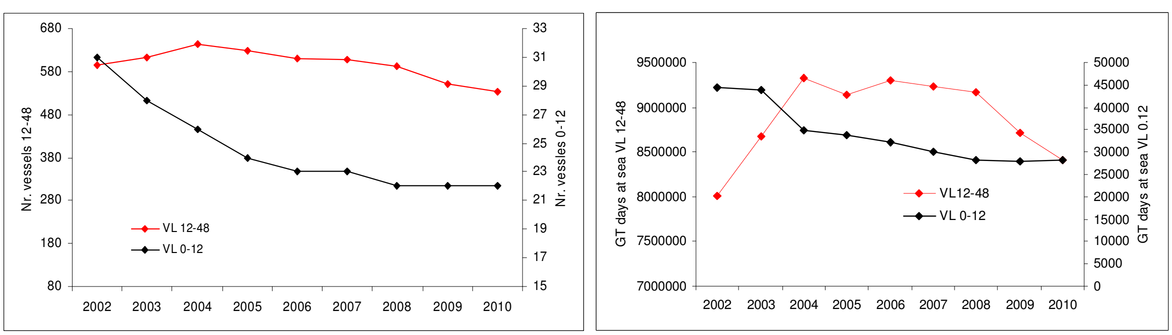


Fig 6.4.2.4.2. Annual GT days at sea (left figure) and number of trawlers (right figure) in GSA 6, according to different vessel length (VL) groups

In contrast to trawlers, for gillnetters both the annual GT days at sea and the annual number of boats show a strong increasing trend (Fig. 6.4.2.4.3).

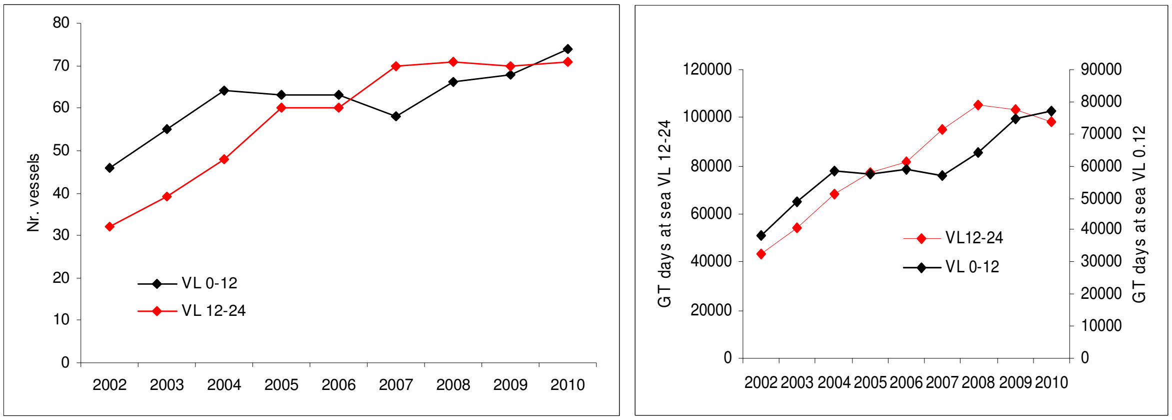


Fig. 6.4.2.4.3. Annual GT days at sea (left figure) and number of gillnetting boats (right figure) in GSA 6, according to different vessel length (VL) groups

6.4.3 Scientific surveys

6.4.3.1 MEDITS

6.4.3.1.1 Methods

Based on the DCF data call, abundance and biomass indices were calculated. Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included). In GSA 06 the following number of hauls was reported per depth stratum (s. Tab. 5.4.3.1.1.1).

Tab. 6.4.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA06_050-100	19	26	26	26	28	29	29	31	36	38	31	32	34	26	28	28	19
GSA06_100-200	11	17	17	15	13	17	18	20	20	21	17	18	19	15	17	20	13
GSA06_200-500	10	12	10	12	7	13	12	16	17	18	16	15	18	13	17	12	10
GSA06_500-800	6	8	9	7	4	9	6	8	7	11	11	8	10	10	11	9	6

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma\,(Yi*Ai) / A$
$V(Yst) = \Sigma\,(Ai^2 * si^2 / ni) / A^2$
Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheet number of plots generated, these distributions are not presented in this report.

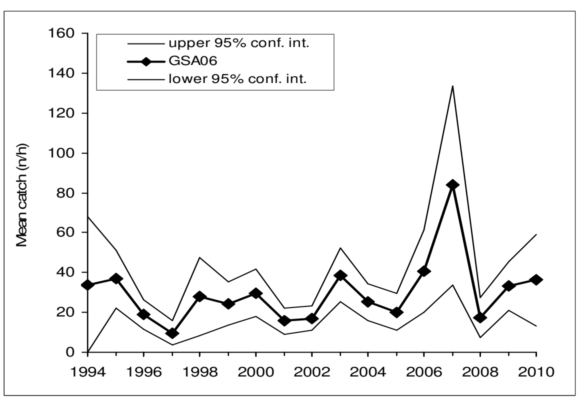
6.4.3.1.2 Geographical distribution patterns

No specific analyses were conducted. However, Lombarte *et al*. (2000) studied the spatial distribution of red mullet in GSA 06 and showed that this species shows a clear preference (higher densities) for muddy areas where the shelf becomes wider.

6.4.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 06 was derived from the international survey MEDITS. Figure 6.4.3.1.3.1 displays the estimated trend in abundance and biomass in GSA 06. Data indicate a general increasing trend in both abundance and biomass since 1996 till 2006; during 2007- 2010 values are low, especially regarding abundance, showing a weak recovery trend.

The hauls indicate a general increasing trend in both abundance and biomass since 1997 till present (2010). This increasing trend does not fit with the negative trend observed in landings. The difference is probably due to the fact that MEDITS surveys, conducted in spring, do not coincide with the recruitment peak (autumn; Sánchez *et al*., 1995).



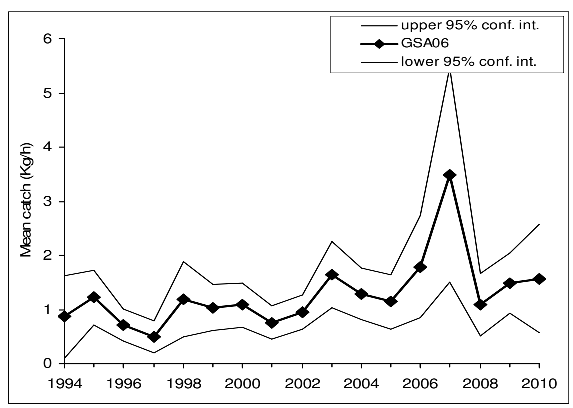
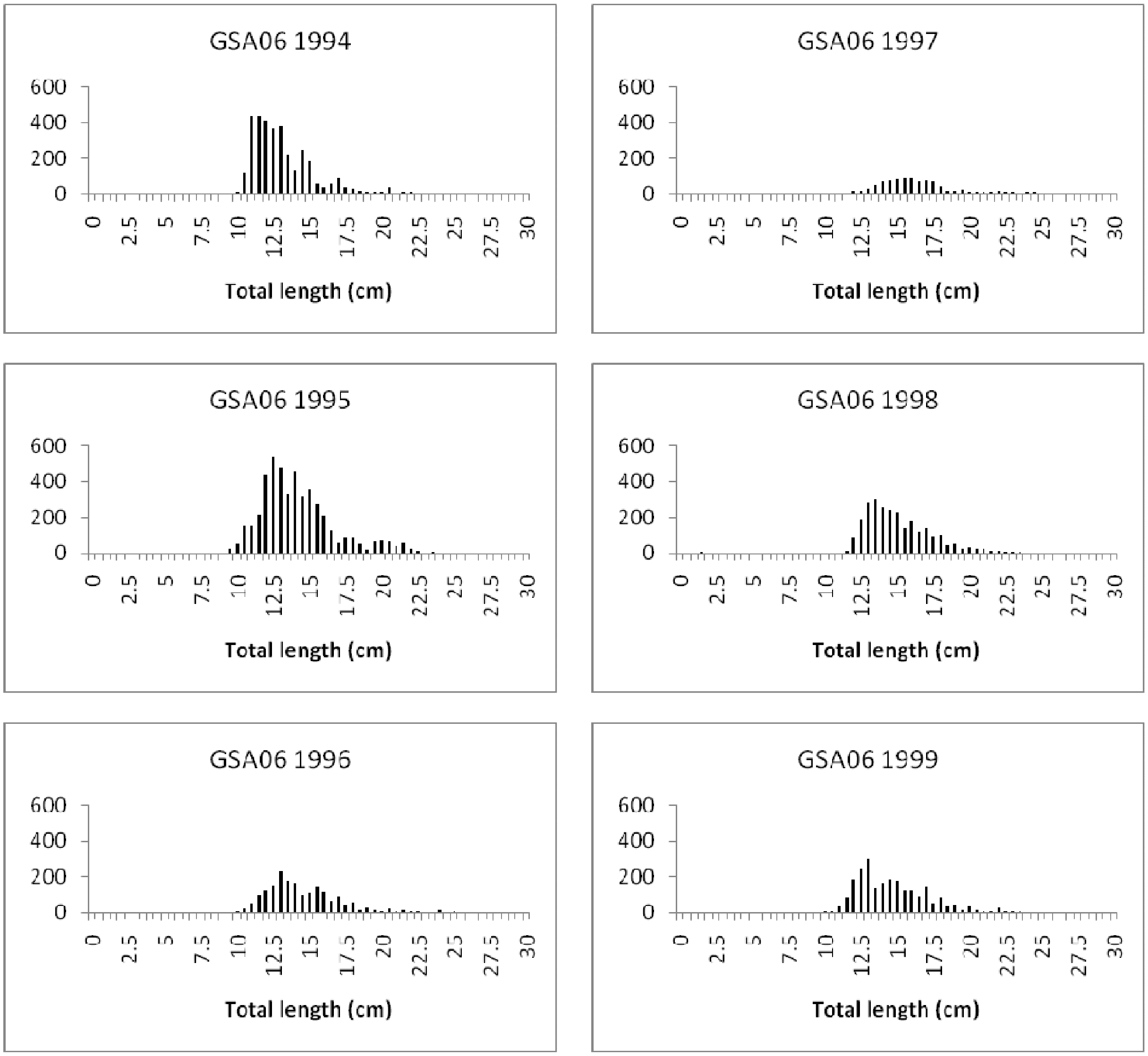
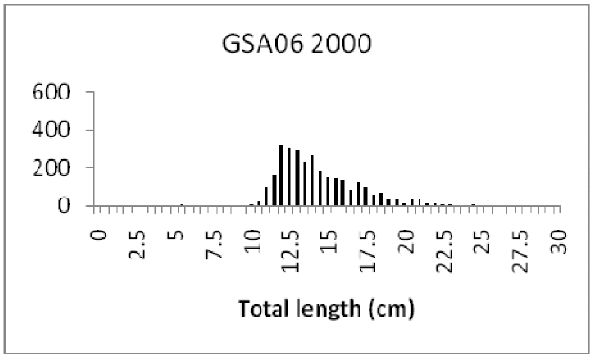


Fig. 6.4.3.1.3.1 Abundance (left fig.) and biomass (right fig.) indices of red mullet in GSA 06.

6.4.3.1.4 Trends in abundance by length or age

The following Fig. 6.4.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2010.





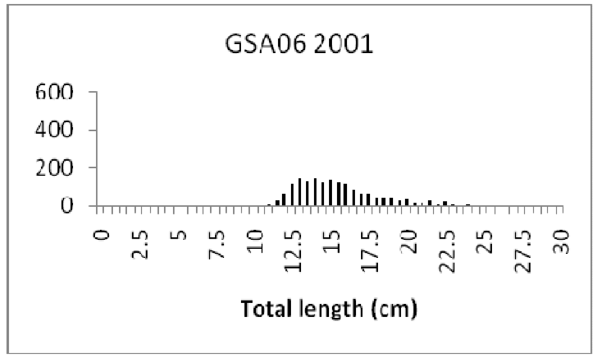
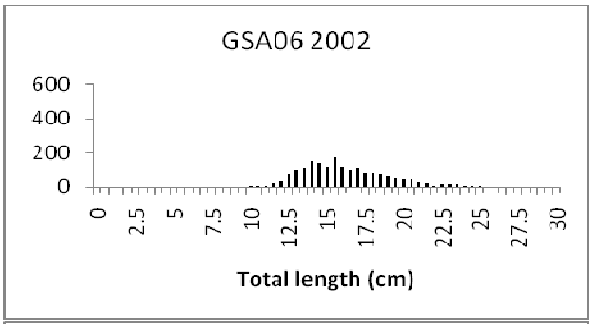
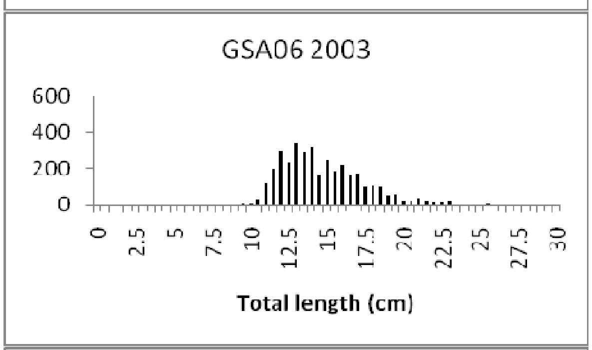
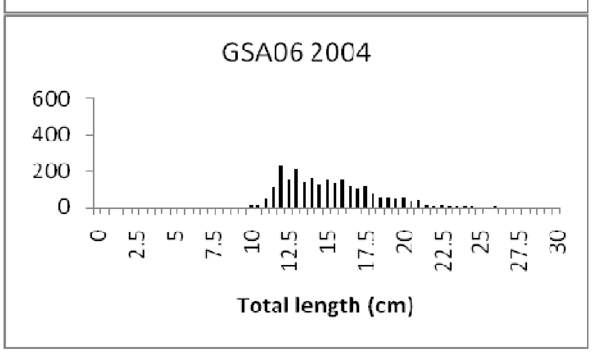
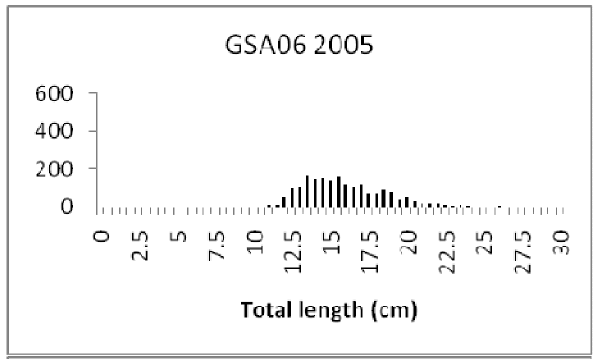


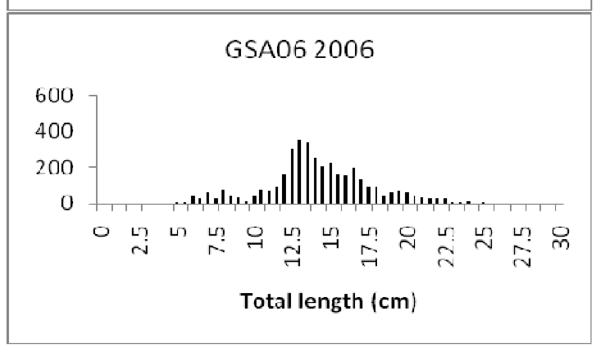
Fig. 6.4.3.1.4.1 Stratified abundance indices by size, 1994-2001.











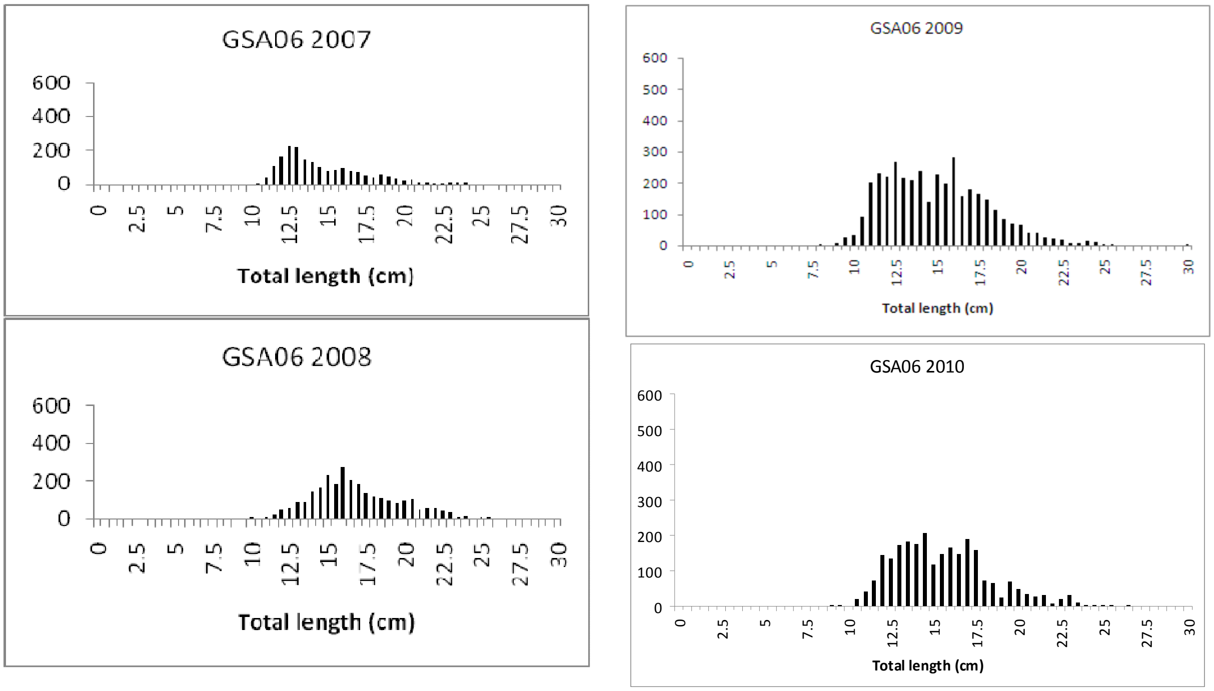


Fig. 6.4.3.1.4.2 Stratified abundance indices by size, 2002-2010.

6.4.3.1.5 Trends in growth

No analyses were conducted during EWG 11-12 meeting.

6.4.3.1.6 Trends in maturity

No analyses were conducted during EWG 11-12 meeting.

6.4.4 Assessments of historic stock parameters

6.4.4.1 Method 1: XSA

6.4.4.1.1 Justification

An XSA was performed calibrated with fishery independent survey abundance indices (MEDITS).

6.4.4.1.2 Input parameters

Input data were taken from DCR. The annual length distributions of the landings in 2010 were transformed to ages using L2Age4 (estimated using the numbers by size and the growth parameters).

We used the growth parameters given in Fernandez 2010 (L_{inf}: 34.5, K=0.34, t_0: -0.143). The growth parameters used here are different from those used in the previous SGMED assessment of red mullet in GSA6 because there were individuals measuring more than 29 cm in our landings, which renders the previous growth curve (which had L_{inf}=29) not appropriate. Minimum and maximum age for the analysis was considered to be age group 0 and 5, respectively.

Table 6.4.4.1.2.1 lists the input parameters to the XSA, i.e. catch at age, weight at age, maturity at age, natural mortality at age and the tuning series at age (MEDITS). Natural mortality values (vector) used in the present assessment are those from Fernandez (2010) as computed using PROBIOM.

The tuning parameters (MEDITS) were calculated by transforming the MEDITS length distributions to ages using L2Age4.exe. Tuning is however limited by the fact that MEDITS and landings are poorly correlated.

It should be also considered that the assessment conducted by EWG 11-12 is based on a short time series of data (2002-2010) and therefore results should be taken with caution.

Table 6.4.4.1.2.1 The input parameters to the XSA, i.e. catch at age, weight at age, maturity at age, natural mortality at age and the tuning series at age (MEDITS).

Red mullet GSA06 Catch at age (thousands).

	YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010
	AGE									
	0	18519	1308	3080	1540	976	57	2144	154	21
	1	31389	21562	26128	25901	36256	23798	12029	14708	9574
	2	4590	7077	8737	6958	8398	8395	6038	6998	9006
	3	286	295	412	267	231	95	465	653	1366
	4	10	22	15	18	12	9	50	49	23
	+gp	0	0	1	0	1	2	7	2	50
0	TOTALNU	54794	30263	38373	34683	45874	32356	20733	22565	20040

Red mullet GSA06 Weight at age in kg.

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE									
0	0.003	0.005	0.005	0.004	0.005	0.005	0.003	0.005	0.005
1	0.016	0.019	0.019	0.019	0.022	0.023	0.026	0.023	0.028
2	0.056	0.059	0.057	0.055	0.055	0.055	0.058	0.061	0.061
3	0.12	0.118	0.117	0.116	0.116	0.119	0.119	0.114	0.119
4	0.177	0.186	0.174	0.181	0.185	0.184	0.191	0.188	0.206
+gp	0.045	0.045	0.249	0.22	0.245	0.246	0.259	0.22	0.258

Male and females combined

Age group	Maturity ratio	M
0	0.46	0.99
1	0.76	0.46
2	0.88	0.30
3	0.93	0.24
4	1	0.21
5	1	0.20

Tuning parameters (MEDITS)

	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE	0.001	0.9	0.001	0.001	266.5	0.001	3.6	6.9	0.001
0	955.2	2495.3	1509.2	1078.2	2413.5	1326.5	1152.1	2388.7	1475.3
1	732.1	978.8	789.3	754.1	922.2	492.1	1378.3	1252.9	943.4
2	72.1	72.1	63.9	77.6	113.1	68.4	242.7	111.2	112.9
3	2.4	6.5	7.9	8.4	3.8	3.1	34	13.8	6.4

6.4.4.1.3 Results including sensivity analyses

The following Table 6.4.4.1.3.1 lists the tuning settings and estimated fishing mortality at age as estimated by XSA.

Table 6.4.4.1.3.1 Tuning settings and fishing mortality 2002-2010 at age and stock numbers at age 2002-2010.

Regression weights									
	0.82	0.877	0.921	0.954	0.976	0.99	0.997	1	1

Log catchability residuals.

Age	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	8.62	-6.16	8.87	8.66	-18.71	9.36	-9.03	-10.07	9.97
1	-0.99	0.87	0.01	-0.81	0.71	-0.19	-0.59	0.78	0.11
2	0.23	0.13	-0.04	0.11	0.31	-0.74	0.37	-0.17	-0.14
3	-0.07	0.08	-0.31	0.33	0.85	-0.1	0.5	-0.16	-1.12
4	-0.37	-0.21	0.44	0.31	0.06	-0.22	0.4	-0.35	-0.33

F										
YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	FBAR 2008-2010
AGE										
0	0.2288	0.0171	0.038	0.0149	0.0138	0.0011	0.0353	0.0037	0.0007	0.0132
1	1.3364	0.9628	1.2397	1.1156	1.3145	1.2073	0.6509	0.7099	0.6364	0.6657
2	2.4884	2.5882	3.1992	3.1196	3.5969	2.5495	2.039	1.5155	2.5976	2.0507
3	2.2392	2.651	2.7888	2.8233	2.8241	0.7486	1.9351	2.9333	2.3867	2.4184
4	1.7146	1.6883	1.7909	1.7742	1.9811	1.3771	1.336	1.5259	1.6012	1.4877
+gp	1.7146	1.6883	1.7909	1.7742	1.9811	1.3771	1.336	1.5259	1.6012	1.4877
FBAR 1-3	2.021	2.067	2.409	2.353	2.579	1.502	1.542	1.720	1.874	1.7116

Stock numbers at age (thousands)

YEAR	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE										
0	148530	126700	135548	170435	116592	85258	101531	69139	46207	0
1	53589	43902	46282	48489	62391	42728	31645	36419	25596	17157
2	5815	8890	10582	8457	10032	10580	8065	10420	11305	8551
3	361	358	495	320	277	204	612	778	1696	624
4	13	30	20	24	15	13	76	70	33	123
+gp	0	0	1	0	1	2	11	3	67	16
TOTAL	208308	179880	192929	227726	189308	138784	141939	116828	84904	26471

The following Table 6.4.4.1.3.2 provides the summary of stock parameters as estimated by XSA.

Table . 6.4.4.1.3.2 Summary of stock parameters as estimated by XSA.

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 1-3
2002	148530	2281	1615	1159	0.7175	2.021
2003	126700	2347	1647	1004	0.6095	2.067
2004	135548	2006	1416	958	0.6764	2.409
2005	170435	2367	1641	1027	0.626	2.353
2006	116592	2824	2033	1437	0.7069	2.579
2007	85258	2431	1784	1232	0.6908	1.502
2008	101531	2417	1810	1056	0.5833	1.542
2009	69139	2285	1726	1011	0.5858	1.720
2010	46207	1815	1432	972	0.679	1.874
Mean	111104	2308	1678	1095	0.6528	2.007
Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)		

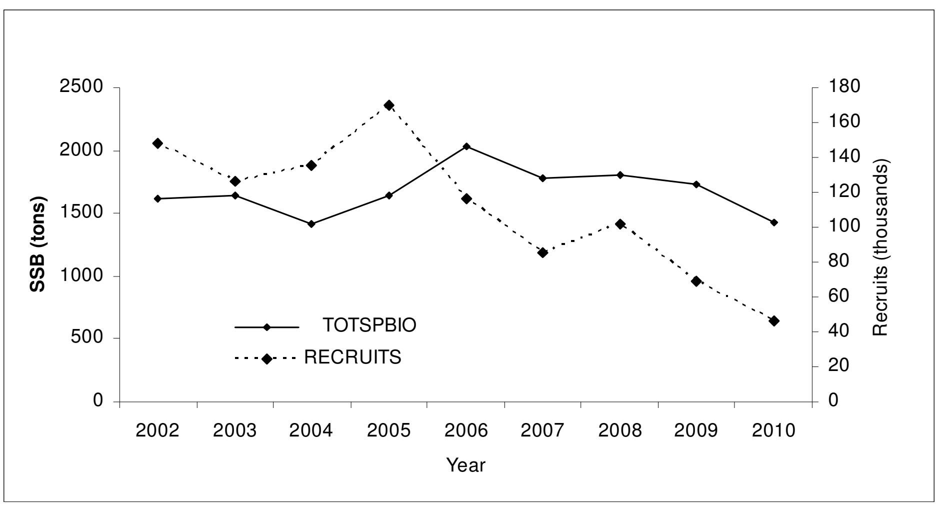


Fig. 6.4.4.1.3.1 Trends in spawning stock SSB and recruits (age 0).

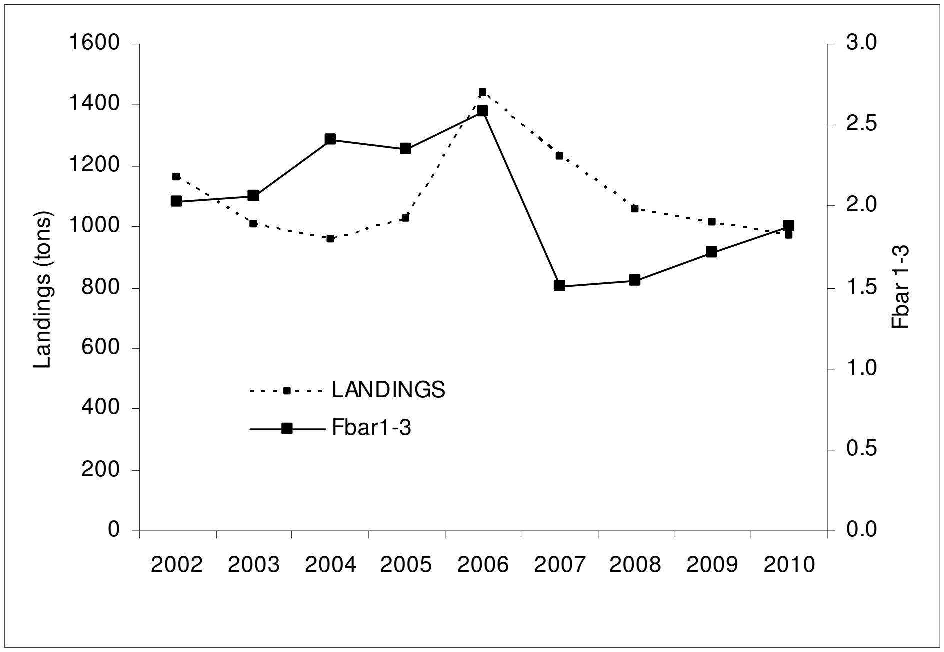


Fig. . 6.4.4.1.3.2 Trends in landings and mean fishing mortality over ages 1-3.

SSB and recruitment show a decreasing trend since 2006 and 2005 respectively, with the 2010 values being the lowest recruitment value recorded. Recruits become mature within their first year of life, and this can explain the one-year lag difference between the declining trend of the recruits and the SSB.

Since class 0 is not fully recruited to the fishing gear, the mean F ages 1-3 is shown, being these ages the most affected by trawl, showing the highest F. Fishing mortality shows an increase since 2007 with the 2010 value being the highest since that year.

Fig. 6.4.4.1.3.3 shows that there is a positive relationship (although not significant, p=0.14) between the F_{bar} 1-3 and the number of trawlers operating annually in the period 2012-2010.

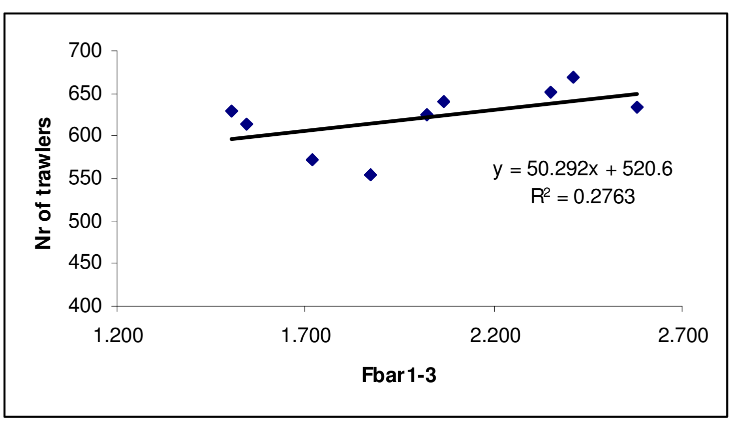


Fig. . 6.4.4.1.3.3. Linear relationship between the number of trawlers and F_{bar} 1-3 (2002-2010)

6.4.5 Long term prediction

6.4.5.1 Justification

The yield per recruit Y/R was used for the estimation of $F_{0.1}$ and F_{max}.

6.4.5.2 Input parameters

F is overaged over ages 1-3. All input parameters are listed in Table 6.4.5.2.1 below.

Table 6.4.5.2.1 YpR inputs.

age group	stock weight	catch weight	maturity	F	M
0	0.003	0.003	0.46	0.0132	0.99
1	0.016	0.016	0.76	0.6657	0.46
2	0.056	0.056	0.88	2.0507	0.30
3	0.120	0.120	0.93	2.4184	0.24
4	0.177	0.177	1	1.4877	0.21
5	0.045	0.045	1	1.6433	0.20

6.4.5.3 Results

$F_{0.1}$ amounts to 0.38. F_{ref} equals 1.9 and was computed as the mean $F_{1\text{-}3}$ in the most recent year (2010) (Figure 6.4.5.3.1). In the previous assessment carried out in SGMED 10-02, a $F_{0.1}$ value of 0.74 was reported, even though it was acknowledged to be imprecise because the Y/R curve presented a flat-top structure that is not now any longer observed. Furthermore, the $F_{0.1}$ value now estimated (0.38) is more consistent with the $F_{0.1}$ estimated for other red mullet stocks.

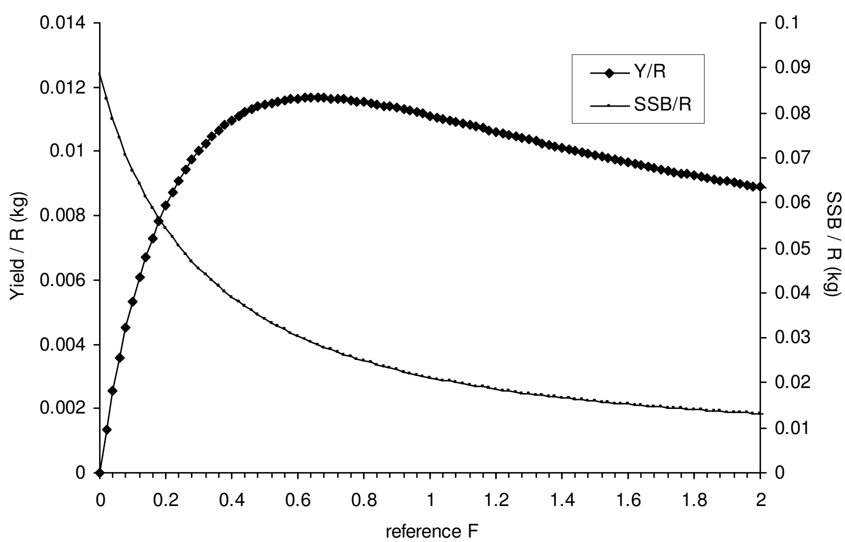


Fig. 6.4.5.3.1 Results of the YpR analysis.

6.4.6 *Data quality and availability*

Data on landings by length class or age group for gillnets were only reported for 2009-2010.

There are large differences when evaluating the relative difference between the red mullet GSA06 landings data submitted in 2011 versus the landings submitted in 2010 for the period 2002-2009 (Fig. 6.4.6.1). Differences can be up to 77%. Although landings submitted in 2011 include trawlers and gillnets (data submitted in 2010 included only trawlers), the large differences are attributed to the fact that landings reported in 2011 by quarter were from logbooks whereas annual landings reported in 2010 were from fish market statistics provided by different regional governments, being the later considered more accurate than the former. This is similar also for red mullet discards.

The 2010 length and age distribution should be taken with caution because there was a change in the sampling methodology in GSA 06: before 2010 the sampling was carried out at the port but in 2010 it was carried out on board at sea. This may have prompted the fishermen to avoid fishing in recruitment grounds while the observers where onboard, and may explain the larger sizes captured in 2010. It seems that this problem is already fixed and corrected by the sampling coordinators, but would be necessary to have the corrected data in the next call.

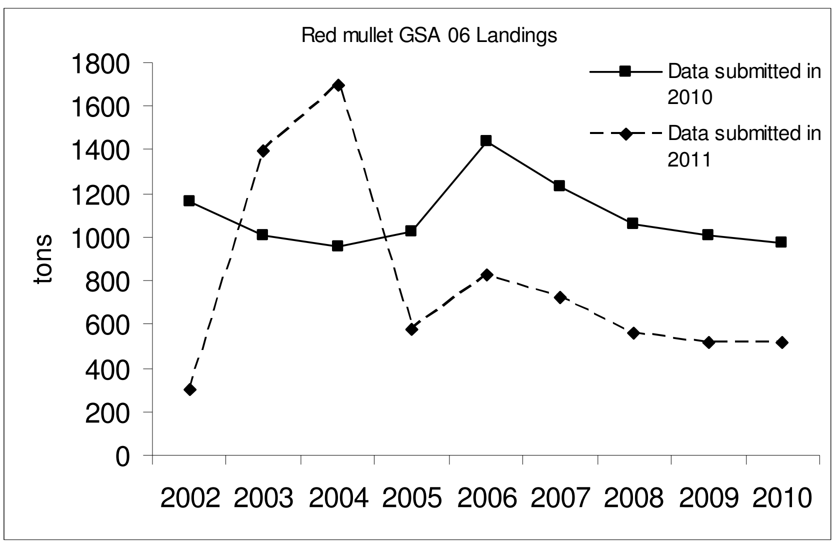


Fig . 6.4.6.1. Differences between red mullet landings according to data from the different calls

6.4.7 *Scientific advice*

6.4.7.1 Short term considerations

6.4.7.1.1 State of the spawning stock size

The SSB in 2010 is below the long term average and a short term recovery seems unlikely if we consider that recruitment in 2010is at the lowest observed level. However, it must be taken into account that age 0 groups are juveniles while 1 year old individuals are already mature; the stock is highly sensitive to recruitment and SSB changes in the short term. It must be noted also that the MEDITS data (which mainly concentrates on the spawning fraction of the population because it is carried out in spring) do not show this pessimistic

Figure. EWG 11-12 considered that this assessment is based on a short time series of data and therefore reference points for biomass or spawning stock biomass should be interpreted with caution. In the absence of a precautionary reference point, STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

6.4.7.1.2 State of recruitment

The recruitment in 2010 attained the lowest value of the time series after a continued decrease since the mid of 2000s.

6.4.7.1.3 State of exploitation

EWG 11-12 revises its earlier proposal and proposes the new estimated $F_{0.1}$=0.38 as proxy of Fmsy and thus as reference point consistern with high long term yield and low risk of fisheries collapse. The revised value is more consistent with the $F_{0.1}$ estimated for other red mullet stocks, particularly with the value estimated by Fernandez (2010). With the F_{ref} being estimated at 1.9, EWG concludes the stock being subject to overfishing. Trawlers, which account for 98% of the landings and the total GT days at sea, and 84% of the boats operating in GSA 06, are responsible for the overexploitation of this stock. The implementation of the use of the 40 mm square mesh in the cod-end (June 2010) seems not to have improved the situation of red mullet stock in GSA 06, which still remains overexploited. The increase of the gillnet effort over the period 2002-2010 should not create any trouble for the stock considering that the major part of recruits and spawners are caught by trawlers. Thus, EWG 11-12 recommends a reduction in trawling fishing effort, particularly during the recruitment season (fourth quarter, when landings are at the maximum) in the context of a multi-annual management plan taking into account the multi-species landings of the trawl and until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

The results from this assessment are in line with the assessment of red mullet in GSA 06 conducted by SCSA/SAC/GFCM in 2010 (Fernandez 2010). That assessment also showed similar results regarding the overexploitation status of the red mullet stock in GSA 06 and the recommendation to decrease the fishing effort by 70%. It is worth noticing that analyses conducted more than ten years ago already highlighted the situation of overexploitation of red mullet in the Spanish Mediterranean shelf (*Martín et al*., 1999; Demestre *et al*., 1997). The review made by Oliver (2000) indicated that from 32 assessments of red mullet conducted in the Mediterranean till 2000 (conducted mostly with VPA or LCA together with a Y/R analysis), in 56% of the cases results showed a state of overfishing while in the 44% left showed a state of fully fished. Thus it appears that the situation is at present much worse than in the 90s according to the latest assessments carried out by the EWG.

The only positive aspect in GSA 06 is that albeit the enforcement of the minimum landing size regulation appeared poorly implemented in the beginning of the 2000s, it has much improved during the last few years. In 2010, less than 5% of the specimens were undersized (i.e. they were below the minimum legal size = 11 cm TL).

6.5 Stock assessment of pink shrimp in GSA 06

6.5.1 Stock identification and biological features

6.5.1.1 Stock Identification

Due to a lack of information about the structure of pink shrimp population in the western Mediterranean, this stock was assumed to be confined within the GSA 06 boundaries.

6.5.1.2 Growth

EWG 11-12 notes that the set of growth parameters used were the same to those used in previous assessment. Growth parameters used were those from Garcia-Rodriguez et al. (2009) over length distributions analysis (L_{inf}= 45.0; K = 0.39; t_0= 0.1019), and length-weight relationship (a= 0.0019; b= 2.611).

6.5.1.3 Maturity

Maturity ogive was taken from García Rodriguez et al. (2009), with size at first maturity (50 %) at 25 mm CL.

Tab. 8.31.1.3.1 Maturity ogive for deep-water pink shrimp in GSA 06.

Age class	0	1	2	3	4	5	6	7
Maturity ratio	0	0.1343973	0.5044019	0.7877772	0.9015605	0.9738161	1	1

6.5.2 Fisheries

6.5.2.1 General description of fisheries

The trawl feet operating in GSA06 in 2009 consisted of 603 trawlers, according to the statistics of the Autonomous Governments of Valence (305 in southern GSA06) and Catalonia (298 in northern GSA06).

Deep-water pink shrimp (*Parapenaeus longirostris*) is one of the most important crustacean species for the trawl fisheries developed along the GFCM geographical sub-area Northern Spain (GSA 06). This resource is an important component of commercial landings in some ports of the Mediterranean Northern Spain and occasionally target species of the trawl fleet, composed by around 600 vessels, and especially by 260 vessels which operate on the upper slope. During the period 2005-2010 stabilization in catches is observed with an average of 115 t for this period.

6.5.2.2 Management regulations applicable in 2010 and 2011

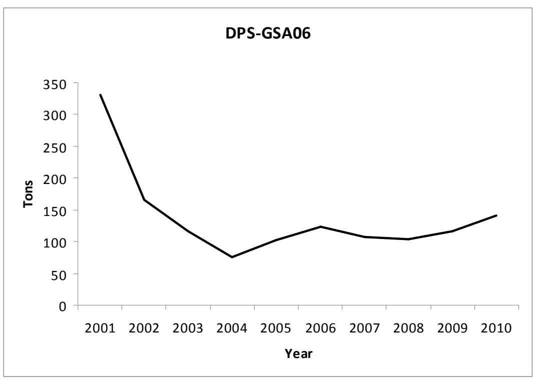
The Spanish Administration acknowledged the poor status of the fishing resources in the Spanish Mediterranean and approved a plan for the conservation of the fishing resources in the Mediterranean, whose implementation is updated on a bi-annual basis (*Orden APA/254/2008, de 31 de enero, por la que se establece un Plan Integral de Gestión para la conservación de los recursos pesqueros en el Mediterráneo; Orden ARM/143/2010, de 25 de enero, por la que se establece un Plan Integral de Gestión para la conservación de los recursos pesqueros en el Mediterráneo*). This regulation, in line with EU regulations, includes the implementation of spatial and temporal closures along the Spanish coast, and limits the daily and weekly fishing effort to 12 hours per day five days a week. The plan affects purse-seining, bottom trawling, surface longlining and artisanal fishing and will end by 31 December 2012. By then, the number of vessels should have been reduced, at least, by 10%.

6.5.2.3 Catches

6.5.2.3.1 Landings

Because of the data quality problems reported in the section below, the absolute values (total annual landings) used in this assessment were those from the old data call, coming from the Autonomous Governments official data instead of the log-books. For the analysis of the relative landings by gear, values were taken from the new data call.

During the last years, a sharp increase in landings was observed, starting in 1998 and reaching the maximum value in 2000, followed by a decreased trend during the period 2001-2004. During the period 2005-2010 landings stabilized to an average of 115 t. In 2010 the annual landings of this species amounts 141 tons in the whole area.



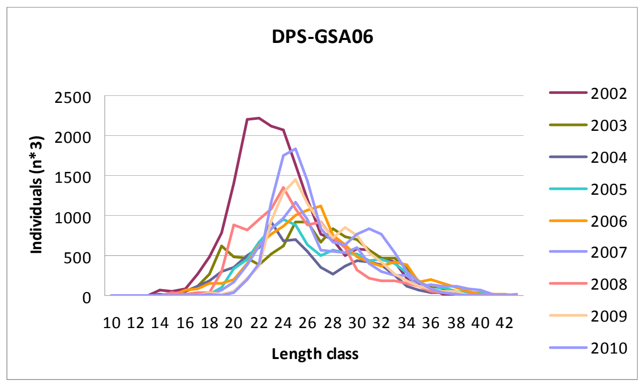


Fig. 6.5.2.3.1.1 annual landings in GSA06, in weight (tons, left) and numbers (right).

Tab. 6.5.2.3.1.1 lists the trend in reported landings by fishing technique. The data were reported to STECF EWG 11-12 through the Data Collection RegulationThe landings were only taken by demersal otter trawls.

Tab. 8.31.2.3.1.1 Annual landings (t) of deep-water pink shrimp by fishing technique in GSA 06.

YEAR	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Landings T	331	165	116	76	102	123	107	104	116	141

6.5.2.3.2 Discards

Reported discards through the DCR data call to EWG 11 12 amount 90 kg in 2005; 416 kg in 2008, 309 kg in 2009 and 816 kg in 2010. No data on the discards size and/or age distributions were submitted.

6.5.2.4 Fishing effort

The trawl fishing effort data for GSA 06 was submitted by the Spanish authorities by quarter, area, gear and vessel length in the new data call. Trawlers (about 600 vessels) are responsible for all the fishing effort devoted to *P. longirostris* in GSA 6 during the period 2002-2010

For trawlers, the annual GT days at sea show a slight decreasing trend since 2004 for large trawlers (12-40 m length) and a continuous decreasing trend since 2002 for small trawlers (0-12 m length; see fig. xxx left). This is in line with the expected reduction of the fleet. Regarding the number of trawlers (annual mean) a similar pattern is observed: the number of large trawlers (12-40 m) shows a slight decrease from 2004 onwards (from about 650 to 550 vessels) whereas the number of small trawlers (0-12 m) decreased from 30 to 22.

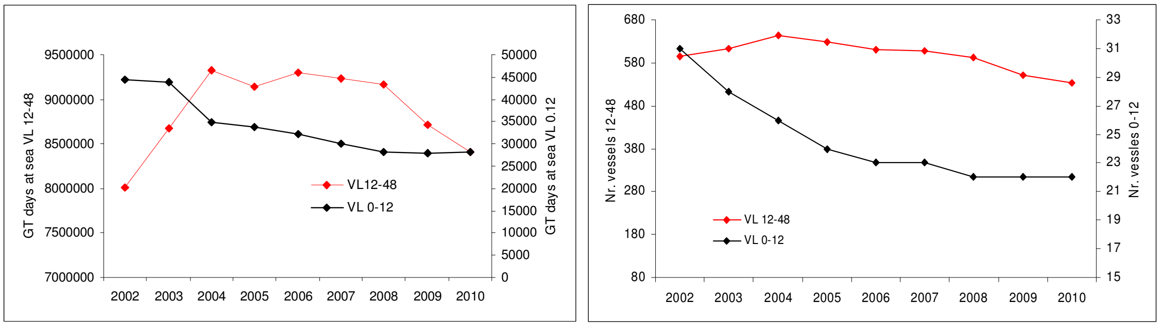


Fig. 6.5.2.4.1. Annual GT days at sea (left figure) and number of trawlers (right figure) in GSA 6, according to different vessel length (VL) groups

6.5.3 Scientific surveys

6.5.3.1 MEDITS

6.5.3.1.1 Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 06 the following number of hauls were reported per depth stratum (s. Tab. 7.31.3.1.1.1).

Tab. 8.31.3.1.1.1. Number of hauls per year and depth stratum in GSA 06, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA06_050-100	19	26	26	26	28	29	29	31	36	38	31	32	34	26	28	28	19
GSA06_100-200	11	17	17	15	13	17	18	20	20	21	17	18	19	15	17	20	13
GSA06_200-500	10	12	10	12	7	13	12	16	17	18	16	15	18	13	17	12	10
GSA06_500-800	6	8	9	7	4	9	6	8	7	11	11	8	10	10	11	9	6

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$
$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$
Where:
A=total survey area

Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.5.3.1.2 Geographical distribution patterns

No analyses were conducted during EWG 11-12 meeting.

6.5.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 06 was derived from the international survey Medits. Figure 6.5.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 06.

EGW notes that the MEDITS survey abundance index shows a very high peak in abundance in the 1999-2001 period, which represents the start of the assessment period. Prior to 1999, abundance levels were comparable to those seen in the 2002-2007 period. In the last tree years, 2008-2010, a recovery trend can be observed.

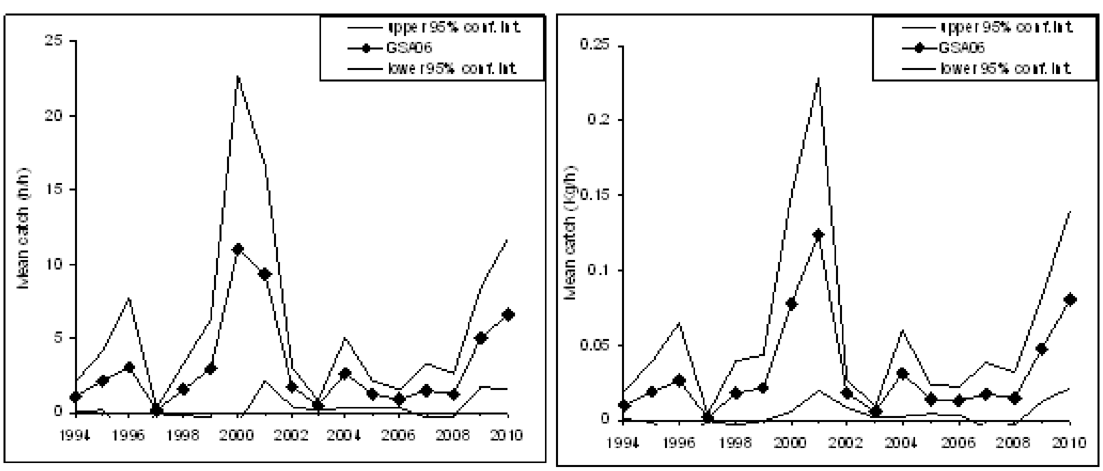


Fig. 6.5.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 06.

6.5.3.1.4 Trends in abundance by length or age

The following Fig. 6.5.3.1.4.1 and 2 display the stratified abundance indices of GSA 06 in 1994-2001 and 2002-2010, respectively.

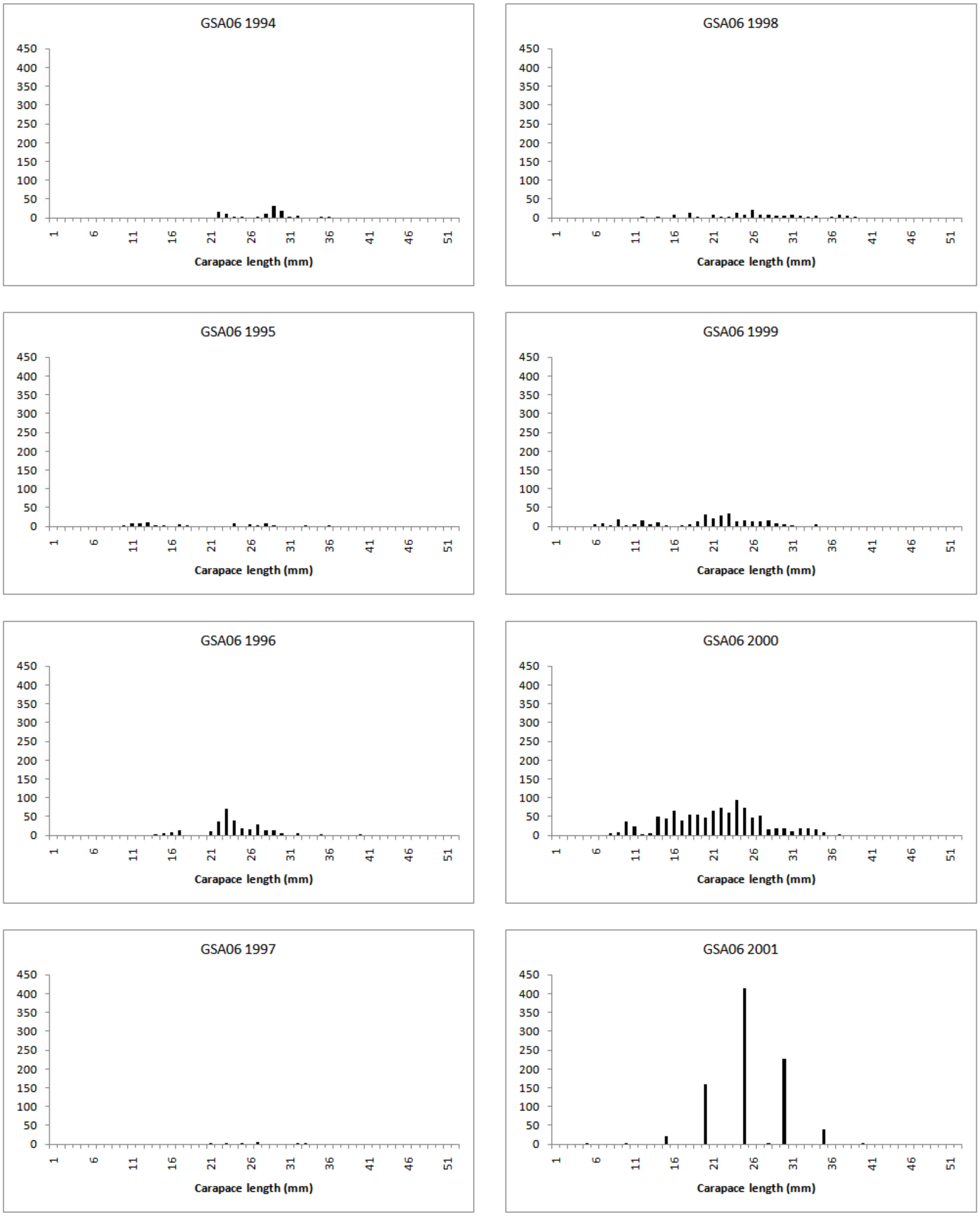
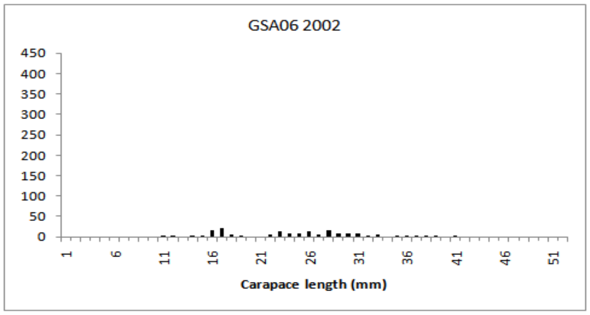
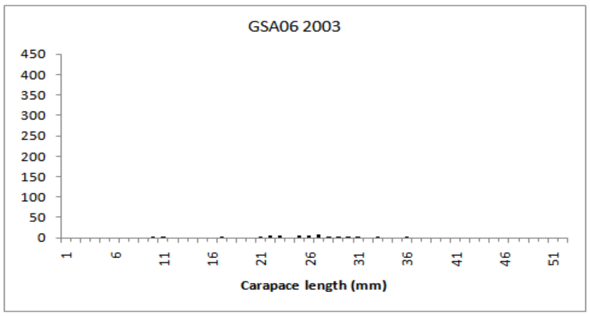
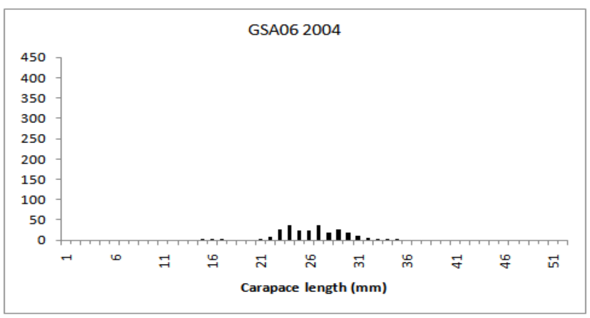
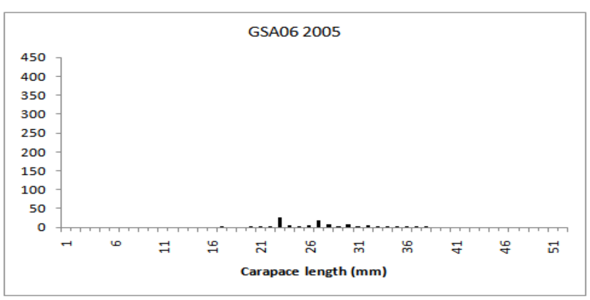


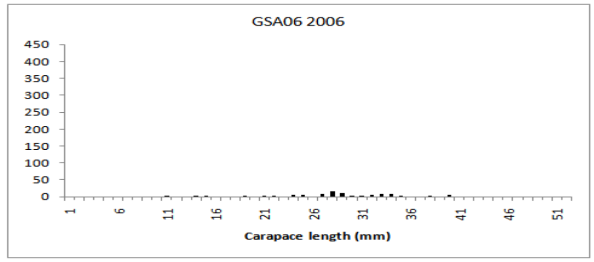
Fig. 6.5.3.1.4.1 Stratified abundance indices by size, 1994-2001.

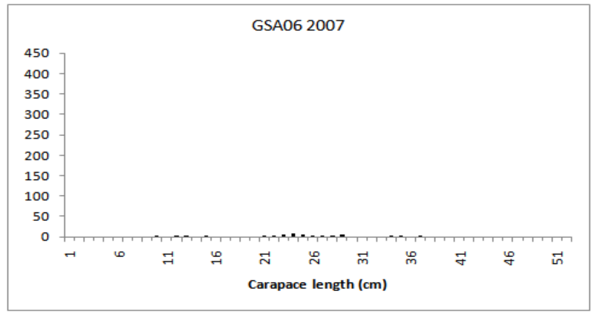


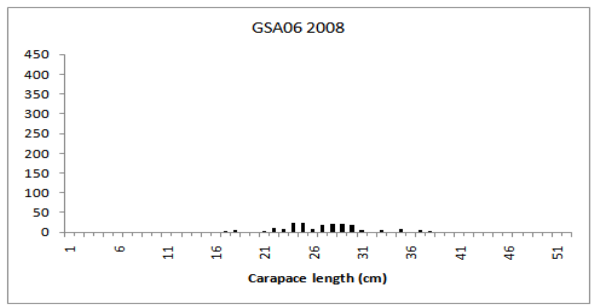


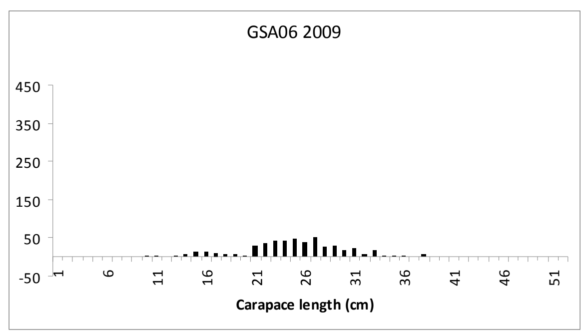












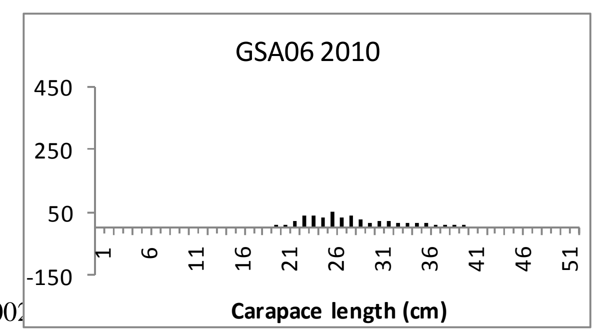


Fig. 6.5.3.1.4.2 Stratified abundance indices by size, 200

6.5.3.1.5 Trends in growth

No analyses were conducted during EWG 11-12 meeting.

6.5.3.1.6 Trends in maturity

No analyses were conducted.

6.5.4 Assessments of historic stock parameters

6.5.4.1 Method 1: XSA

6.5.4.1.1 Justification

During the STECF EWG 11 12 meeting, an assessment on pink shrimp from GSA 06 was performed. An XSA was performed calibrated with fishery independent survey abundance indices (MEDITS).

6.5.4.1.2 Input parameters

The state of exploitation was assessed for the period 2001-2010 for the GFCM geographical sub-area Northern Spain (GSA-06). A VPA tunned with CPUE from commercial fleet and abundance indices from MEDITS trawl surveys, was carried out applying the Extended Survivor Analysis (XSA) method (Lowestoft program; Darby and Flatman, 1994) over the period 2001-2010. This method was performed from size composition of trawl catches (obtained from on board and on port monthly sampling) and official landings transforming length data to age data by slicing. Available CPUE data series, both of commercial fisheries, from Santa Pola fleet, and scientific survey MEDITS were used.

The growth parameters are: L_{inf}= 45.0; K = 0.39; t_0= 0.1019. Numbers by age were estimated transforming the annual size distribution of the landings to ages using the L2Age4 software. The tuning parameters (MEDITS) were calculated by transforming the MEDITS length distributions to ages using L2Age4 software.

Table 6.5.4.1.2.1 lists the input parameters to the XSA, i.e. catch at age, weight at age, maturity at age, natural mortality at age and the tuning series at age (MEDITS). Natural mortality values (vector) were computed with PROBIOM. M of age group 0 is the mean over the first 12 months

The following Table 6.5.4.1.2.1 lists the various input parameters at age.

Tab. 6.5.4.1.2.1 XSA input parameters. i.e. catch at age, weight at age, maturity at age, natural mortality at age and the tuning series at age from MEDITS.

CATCH AT AGE

YEAR		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE											
	0	141.700	31.000	1.700	7.200	0.000	0.000	0.000	0.000	0.000	0.000
	1	19754.600	10381.000	3128.200	3287.500	2758.100	2763.000	2428.300	4615.200	2077.300	2453.900
	2	14222.700	6710.900	5175.700	3105.600	4266.800	5622.400	4994.200	5377.500	6654.300	7281.100
	3	3270.700	1714.500	1908.800	1194.800	1645.300	1660.300	1238.900	781.900	1427.800	2486.700
	4	346.500	193.900	277.200	100.400	272.700	487.900	379.600	163.300	203.600	193.500
	5	24.400	19.200	32.800	9.800	68.300	108.000	174.800	29.400	25.800	7.600
6+		1.000	1.700	6.900	1.000	25.300	34.600	41.700	15.500	1.000	0.700

WEIGTH AT AGE (kg)

YEAR		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE											
	0	0.002	0.002	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	1	0.006	0.006	0.006	0.006	0.007	0.006	0.007	0.006	0.007	0.007
	2	0.011	0.011	0.012	0.011	0.011	0.011	0.011	0.011	0.011	0.011
	3	0.018	0.018	0.019	0.018	0.019	0.019	0.019	0.019	0.018	0.018
	4	0.024	0.024	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.024
	5	0.030	0.03	0.03	0.029	0.03	0.03	0.03	0.03	0.029	0.029
6+		0.032	0.032	0.034	0.032	0.034	0.035	0.034	0.034	0.032	0.032

Maturity:

Size at first maturiry (50%) 25.65mm

DCF

0	0.1343973	Natural morta Vector (Abella
1	0.5044019	
2	0.7877772	
3	0.9015605	
4	0.9738161	
5	1	
6	1	
+gp	1	

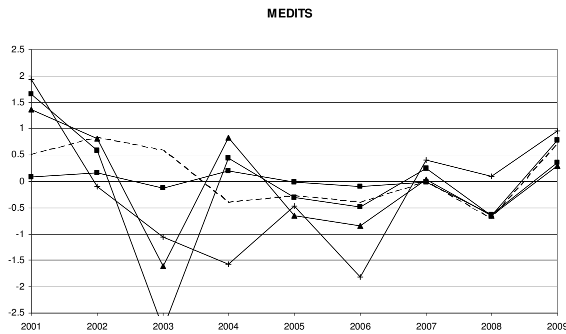
0	1.25
1	0.82
2	0.39
3	0.28
4	0.24
5	0.22
6	0.21
+gp	0.2

TUNNING (MEDITS)

YEAR		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
AGE											
	0	0.6	0.5	0.4	0.1	0.1	0.1	0.3	0.1	0.6	0.1
	1	18.8	7.3	1	3.1	1.7	0.9	1.7	0.9	11.8	4.9
	2	51.5	21.2	1.5	18.4	4.1	3	5.7	3.9	15.8	22.7
	3	11.4	3	0.1	2.8	2	1.2	1.5	0.5	3	5.6
	4	2.5	0.3	0.1	0.1	0.5	0.2	0.7	0.3	0.5	1.9
	5	0.1	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.3	1.1
6+		0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1

6.5.4.1.3 Results including sensivity analyses

Pink shrimp XSA model diagnostics are shown in Fig. 6.5.4.1.3.1 and Table 6.5.4.1.3.1. No numeric blocks or trends in the log catchability residuals are recognizable.



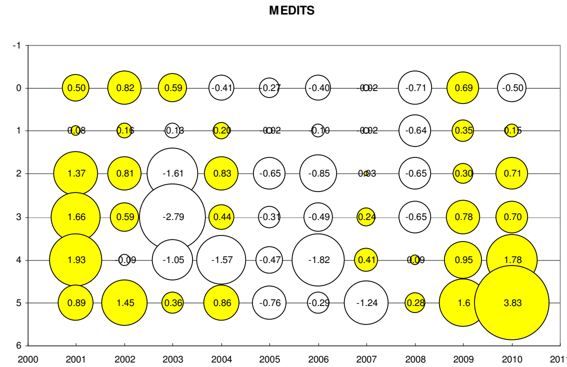


Fig. 6.5.4.1.3.1. Log catchability residual plots (XSA) for single fleets, MEDITS

Table 6.5.4.1.3.1. Pink shrimp XSA model diagnosis.

Fleet : MEDITS

Age	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
0	0.5	0.82	0.59	-0.41	-0.27	-0.4	-0.02	-0.71	0.69	-0.5
1	0.08	0.16	-0.13	0.2	-0.02	-0.1	-0.02	-0.64	0.35	0.15
2	1.37	0.81	-1.61	0.83	-0.65	-0.85	0.03	-0.65	0.3	0.71
3	1.66	0.59	-2.79	0.44	-0.31	-0.49	0.24	-0.65	0.78	0.7
4	1.93	-0.09	-1.05	-1.57	-0.47	-1.82	0.41	0.09	0.95	1.78
5	0.89	1.45	0.36	0.86	-0.76	-0.29	-1.24	0.28	1.6	3.83

Mean log catchability and standard error of ages with catchability independent of year class strength and constant w.r.t. time

Age	2	3	4	5
Mean Log q	-11.1842	-11.1762	-10.7609	-10.7609
S.E(Log q)	0.9167	1.1664	1.2865	1.6497

Table 6.5.4.1.3.2 Fishing mortality at age as estimated by XSA.

Table 8 Fishing mortality (F) at age

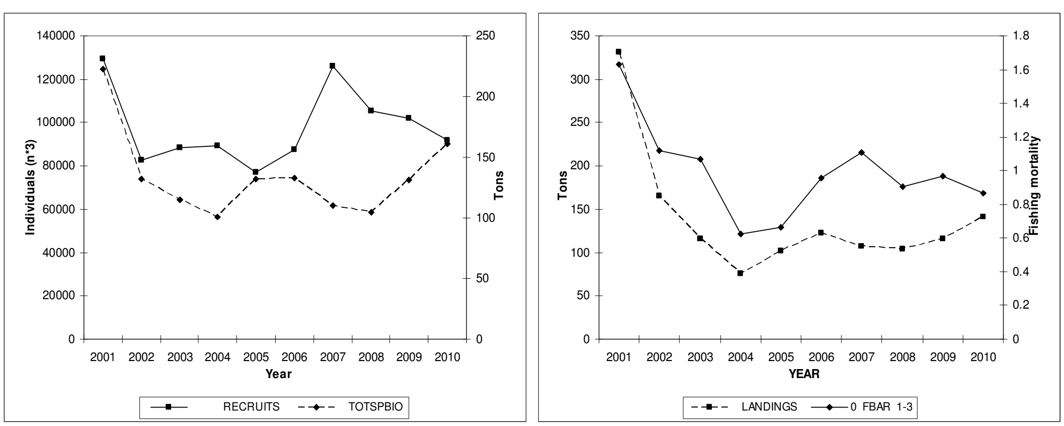
YEAR		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	FBAR **-*
AGE												
	0	0.002	0.0007	0	0.0002	0	0	0	0	0	0	0
	1	0.7393	0.5495	0.2224	0.2176	0.1778	0.2092	0.1577	0.2136	0.1094	0.1161	0.1464
	2	1.7606	1.142	1.1048	0.6028	0.8619	1.2964	1.4702	1.1795	0.9911	1.0266	1.0657
	3	2.3882	1.669	1.8852	1.054	0.9486	1.3626	1.7045	1.3214	1.8086	1.4517	1.5272
	4	2.2946	1.4302	2.3342	0.4799	0.8057	0.9376	1.9794	1.4657	2.6339	1.4952	1.8649
	5	1.4303	0.9732	1.13	0.5357	0.7494	0.9604	1.2061	0.9368	1.0855	0.7497	0.924
+gp		1.4303	0.9732	1.13	0.5357	0.7494	0.9604	1.2061	0.9368	1.0855	0.7497	0.97571
0 FBAR 0- 5		1.4358	0.9608	1.1128	0.4817	0.5906	0.7944	1.0863	0.8528	1.1048	0.8065	

Table 6.5.4.1.3.3 Stock numbers at age as estimated by XSA.

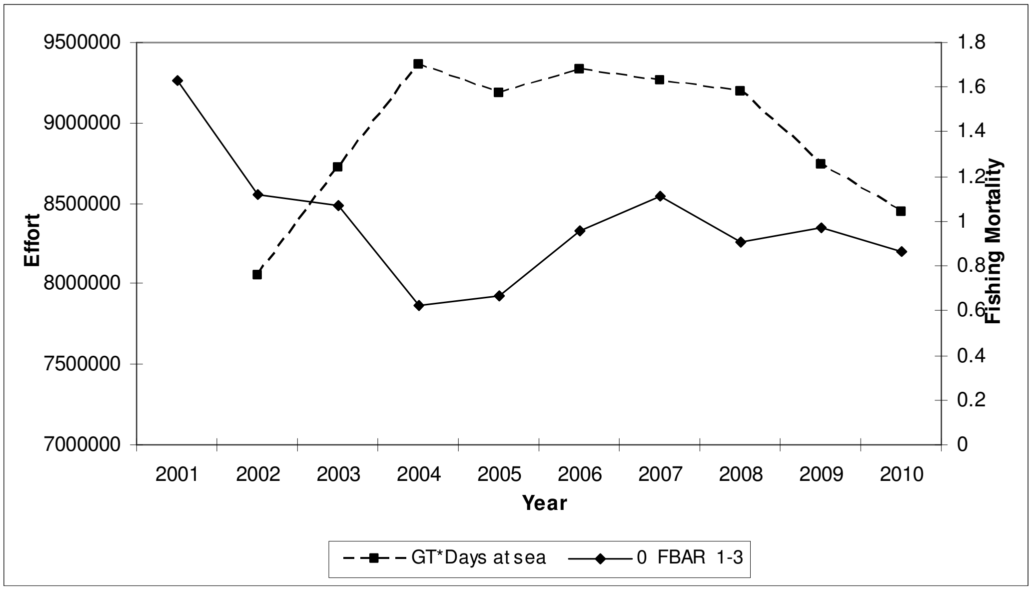
Table 10	Stock number at age (start of year)		Numbers*10**-3								
YEAR		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
AGE												
	0	129403	82575	88432	89057	76989	87554	126188	105469	101842	92021	0
	1	56965	36999	23641	25335	25511	22058	25085	36153	30217	29178	26364
	2	20874	11979	9406	8336	8977	9406	7881	9437	12860	11930	11442
	3	4142	2430	2589	2110	3089	2567	1742	1227	1964	3232	2893
	4	434	287	346	297	556	904	497	239	247	243	572
	5	36	34	54	26	145	195	278	54	43	14	43
+gp		1	3	11	3	53	61	65	28	2	1	6
0 TOTAL		211856	134308	124479	125164	115318	122745	161735	152607	147177	136619	41320

Tab. 6.5.4.1.3.4 Summary of estimated stock parameters, 2002-2010.

YEAR		Age 0 RECRUITS	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	0 FBAR 1-3
	2001	129403	884	223	331	1.4859	1.629
	2002	82575	546	132	165	1.2479	1.120
	2003	88432	455	115	116	1.0064	1.071
	2004	89057	455	101	76	0.7514	0.625
	2005	76989	412	132	102	0.7738	0.663
	2006	87554	391	133	123	0.9268	0.956
	2007	126188	426	110	107	0.9713	1.111
	2008	105469	444	105	104	0.9945	0.905
	2009	101842	484	131	116	0.8871	0.970
	2010	92021	546	161	141	0.8757	0.865
% MAX VALUE 2001		71.11195258	61.7647059	72.1973094	42.5981873		
Mean		97953	504	134	138	0.9921	0.991



6.5.4.1.3.2 Estimated trends in spawning stock biomass SSB, recruits and mean fishing mortality at ages 1-3.



6.5.4.1.3.3 Trends in effort and mean fishing mortality over ages 1-3.

The results show a decreasing trend both in landings and total biomass of the stock from 2001 to 2004 and 2003 respectively. Landings, biomass and SSB values remain at the same level for the last seven years with light fluctuations. Although these values are low compared with 2001 values (the highest in the series).

Exploitation is based on very young age classes, mainly 2 and 1 year old individuals, indicating a dependence on recruitments. Fishing mortality shows a decreasing trend from 2001 to 2004 but increasing in the 2005-2010 period.

6.5.5 Long term prediction

6.5.5.1 Justification

The yield per recruit Y/R was used for the estimation of $F_{0.1}$ and F_{max}.

6.5.5.2 Input parameters

F_{ref} is $Fbar_{1-3}$ over 2001-2010. All input parameters are listed in Table 6.5.5.2.1 below.

Table 6.5.5.2.1 Y/R inputs.

age group	stock weight	catch weight	maturity	F	M
0	0.002	0.002	0.1343973	0.1344	1.25
1	0.006	0.006	0.5044019	0.5044	0.82
2	0.011	0.011	0.7877772	0.7878	0.39
3	0.018	0.018	0.9015605	0.9016	0.28
4	0.024	0.024	0.9738161	0.9738	0.24
5	0.030	0.030	1	1.0000	0.22
6	0.032	0.032	1	1.0000	0.21

6.5.5.3 Results

Results are shown in Fig. 6.5.5.3.1: F_{ref} = 1.0; $F_{0.1}$ = 0.25; F_{max} = 1.99

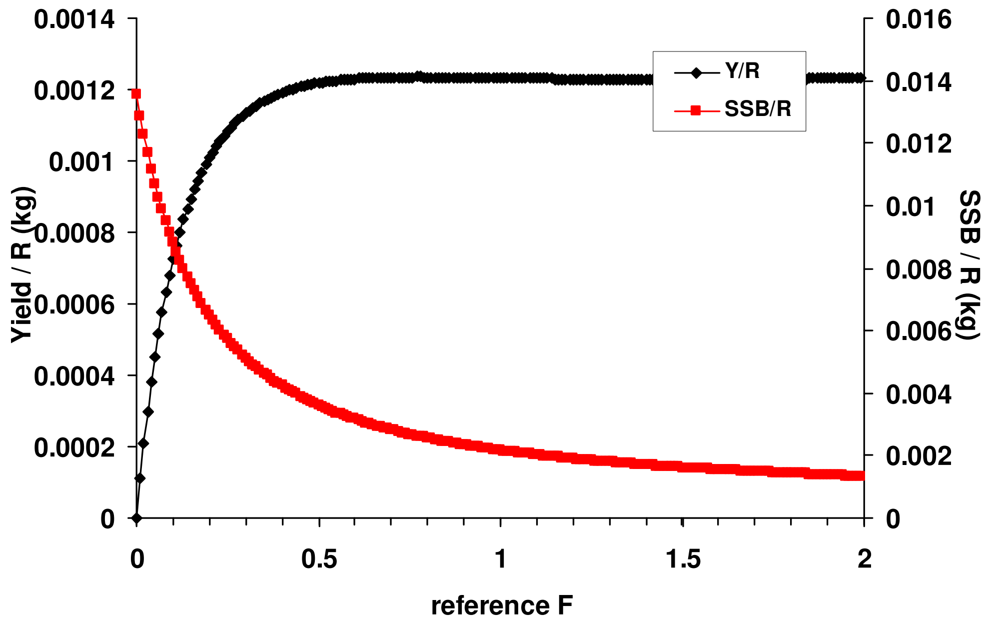


Fig. 6.5.5.3.1 Results of the Y/R analysis, Y/R and SSB/R.

6.5.6 Data quality and availability

There are large differences when evaluating the relative difference between the pink shrimp GSA6 landings data submitted in 2011 versus the landings submitted in 2010 for the period 2002-2009. The large differences are attributed to the fact that landings reported in 2011 by quarter were from logbooks whereas landings reported in 2010 were from fish market statistics provided by different regional governments, being the later considered here more accurate than the former to evaluate the total annual catch.

Inconsistencies between files: The numbers of the annual landings and those of the annual landings by size are not coincidental in four (2002-2005) out of eight years of sampling (2002-2009). Largest inconsistency was observed for 2004 (40% of difference in numbers between the file of landings and the file of landings by size).

Data not available: No data was available on the discards sizes or age distributions.

Growth parameters: Growth parameters given for 2005-2007 and for 2008-2009 are the same.

For the EWG 11-12 a data set was used, based on length frequencies analysis assuming a slow grow hypothesis (L_{inf}= 45 mm, k= 0.39, t_o= -0.1019).

Discards: According to the received data, discards are almost negligible.

6.5.7 Scientific advice

6.5.7.1 Short term considerations

6.5.7.1.1 State of the spawning stock size

Since 2001, SSB is indicated vary without a clear trend. In 2010, the SSB appears to have increased. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the stock size status.

6.5.7.1.2 State of recruitment

Since 2001 recruits (aged 0 individuals) were estimated to vary without a clear trend.

6.5.7.1.3 State of exploitation

The STECF EWG 11-12 recommends $F_{0.1}$ = 0.25 (Fmsy proxy) as management reference point consistent with high long term yields and low risk of fisheries colloapse.

Fishing mortality over ages 0-5 displays a high variation with an average value of 1.0. By comparing $F_{0.1}$ and F_{max} against F_{ref}, taking as reference F_{bar} 1-3 over 2001-2010, it can be concluded that the resource is subject to overexploitation.

The size composition of landings indicates that the exploitation is based on the very young age classes, mainly 1 and 2 years old. The continued low abundance of adult fish in the population and landings indicate a very high exploitation pattern far in excess of those achieving high yields and low risk of fisheries collapse.

F and effort should be decreased until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

EWG 11-12 recommends a recovery plan to be established for this stock that takes into account the mixed species nature of the fishery.

6.6 Stock assessment of hake in GSA 09

6.6.1 Stock identification and biological features

6.6.1.1 Stock Identification

Due to a lack of information about the structure of hake populations in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries.

Hake is distributed in the whole area between 10 and 800 m depth (Biagi et al., 2002; Colloca et al., 2003). Recruits peak in abundance between 150 and 250 m depth over the continental shelf-break and appear to move slightly deeper when they reach 10 cm total length. Crinoid (*Leptometra phalangium*) bottoms over the shelf-break are the main settlement habitat for hake in the area (Colloca *et al*., 2004, 2006; Reale *et al*., 2005). Migration from nurseries takes place when juveniles attained a critical size between 13 and 15.5 cm TL (Bartolino et al., 2008a). Maturing hakes (15-35 cm TL) persist on the continental shelf with a preference for water of 70-100 m depth, while larger hakes can be found in a larger depth range from the shelf to the upper slope. Juveniles show a patchy distribution with some main density hot spots (i.e. nurseries areas) showing a high spatio-temporal persistence (Abella *et al*., 2005; Colloca *et al*., 2006; 2009; Jona Lasinio *et al*., 2007) (Fig. 5.7.1.1.1) in areas with frontal systems and other oceanographic structures that can enhance larval retention (Abella *et al*., 2008).

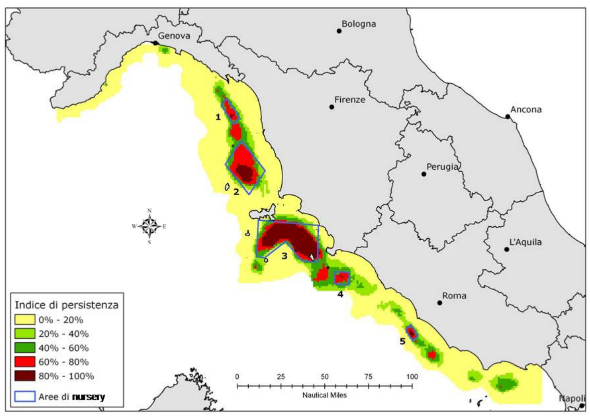
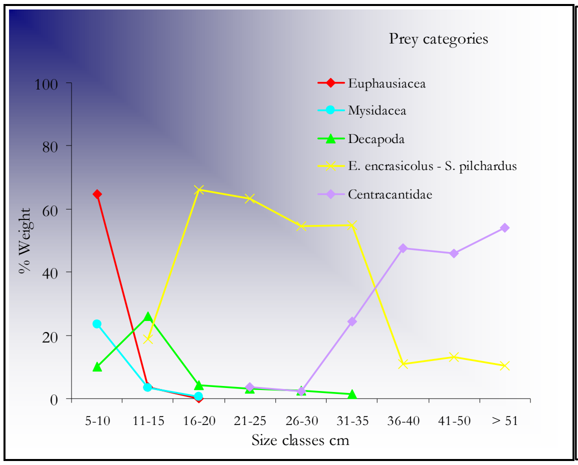
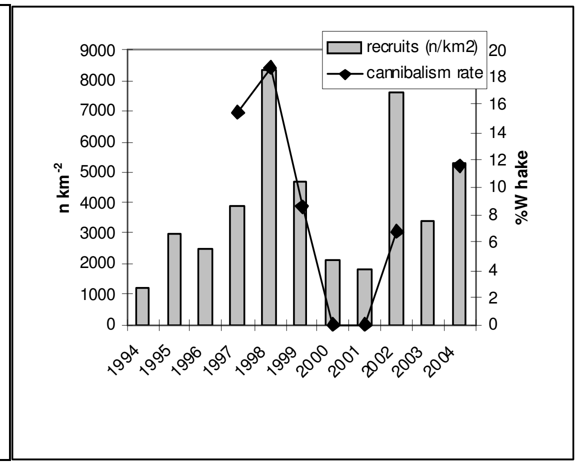


Fig 6.6.1.1.1 Temporal persistence of hake nurseries calculated from MEDITS and GRUND time-series density maps (1994-2005) of juveniles.

Although hakes are demersal fish feeding typically upon fast-moving pelagic preys while ambushed in the water column (Alheit and Pitcher, 1995), there is evidence that hakes feed in mid-water or at the surface during night-time, undertaking daily vertical migrations (Orsi-Relini *et al*., 1989, Carpentieri *et al*., 2008) which are more intense for juveniles. In GSA 09 many different studies are available on hake diet. Results from stomach data collected in the 1996-2001 period can be found in Sartor et al. (2003a) and Carpentieri et al. (2005). Hake diet shifts from euphausids and mysiids consumed by smaller hake (<16 cm TL), to fishes consumed by larger hake.

Before the transition to the complete ichthyophagous phase (TL> 36 cm) hake shows more generalized feeding habits where decapods, benthic (Gobiidae, *Callionymus* spp.,) and necktonic fish (*S. pilchardus, E. encrasicolus*) dominated the diet, whereas cephalopods had a lower incidence (Fig. 5.7.1.1.2).





A) B)

Fig. 6.6.1.1.2 A) Hake diet composition in GSA 09 by size class (from Carpentieri *et al.*, 2005). B) Relationships between recruitment and cannibalism rate (proportion by weight, %W, of hake in hake stomachs).

Estimation of cannibalism rate has been provided for the southern part of the GSA (Latium, EU Because project). Cannibalism increased with size and can be considered significant for hakes between 30 and 40 cm TL (up to 20% by weight in diet) and seems to relate closely to hake recruitment density and level of spatial overlapping.

Consumption rate has been estimated for juveniles and piscivorous hakes. Daily consumption of juveniles, calculated in proportion of body weight (%BW), varied between 5 (July) and 5.9 % BW (Carpentieri et al., 2008). The estimated relative daily consumption for hake between 14 and 40 cm TL, using a bioenergetic approach (EU Because project), was between 2.9 and 2.3 BW%.

6.6.1.2 Growth

Juvenile growth rate was estimated to be about 1.5 cm.month^{-1} using daily growth increments on otoliths (Belcari et al., 2006). According to this growth rate, hake reaches an average length of about 18 cm TL at the end of the first year. According to these observations, the growth of hake in the GSA 09 seems to follow the pattern estimated in the NW Mediterranean (Garcia-Rodriguez and Esteban, 2002) adopting the hypothesis that two rings are laid down on otoliths each year. This new interpretation of otolith ring patterns returns a growth rate (L_∞ = 103.9, K/year = 0.212, t_0 =0.031) almost double than that assumed in the past.

As showed in the Fig. 6.6.1.2.1, cohorts obtained through age slicing of LFDS MEDITS data according to fast growth parameters, can be consistently followed during time, while a less reliable pattern was obtained using parameters conform to the slow growth hypothesis.

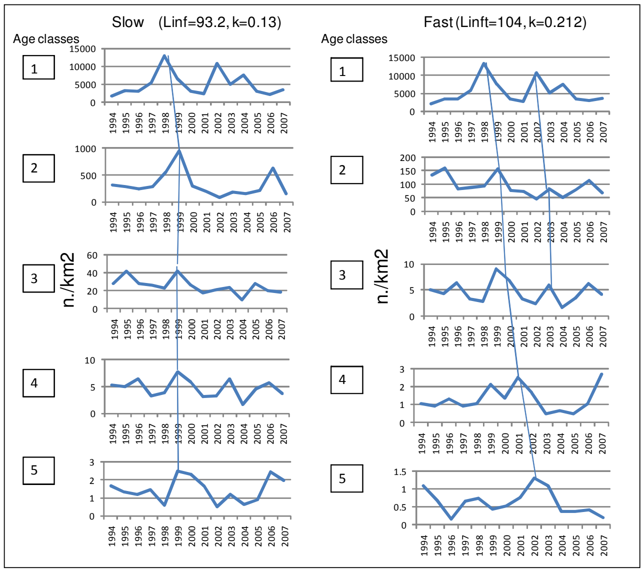


Fig. 6.6.1.2.1 Trends in abundance of age classes obtained using age slicing according to two different sets of growth parameters on MEDITS data.

6.6.1.3 Maturity

The catchability of hake spawners to the Mediterranean trawl nets is rather limited. The distribution of adults which are more abundant on deeper or untrawable grounds, or the ability of larger fish to avoid capture have been claimed as causes of the observed extremely reduced catch of adult hake by trawlers in the Mediterranean (Abella *et al.*, 1997). Also during trawl surveys (MEDITS and GRUND) the catch rate of mature specimens was very low, reducing the possibility of use trawl survey data to explore patterns in gonad development as well as the relationships between growth rate and maturation processes.

Large size hake are targets of a specifically targeted gillnet fishery carried out by several vessels working in the southern part (northern and central Tyrrhenian Sea) of the GSA 09 (Sartor *et al.*, 2001a).

Reproductive biology and fecundity of hake have been studied in northern Tyrrhenian Sea (Biagi *et al.*, 1995; Nannini *et al.*, 2001; Recasens *et al.*, 2008) by monthly samplings of adults caught by trawling and gillnets.

Females in advanced maturity stages, spawning and partial post-spawning are present all year round, but reproductive activity is concentrated from January to May, with two peaks of spawning in February and May. The presence of hake spawners seems to be more concentrated in the southern part of GSA 09.

Female length at first maturity was estimated at 35 cm TL in northern Tyrrhenian Sea (Recasens *et al.*, 2008). This value is consistent with the observations obtained from trawl surveys over the Latium (Colloca, pers. comm.) reporting first maturity from 31 to 37 cm TL for females and from 21 to 25 cm TL for males.

Batch fecundity was about 200 eggs per gonad-free female gram, with asynchronous oocyte development (Recasens *et al.*, 2008).

6.6.2 Fisheries

6.6.2.1 General description of fisheries

Hake is the demersal species providing the highest landings and incomes in the GSA 09. About 60% of landings of hake are due to bottom trawl vessels; the remaining fraction is caught by artisanal vessels using set nets, in particular gillnets. Hake trawl fishery exploits a highly diversified species assemblage: horned octopus (*Eledone cirrhosa*), poor cod (*Trisopterus minutus capelanus*), squids (*Illex coindetii*), are among the most important species in the by catch. The trawl fleet of GSA 09 at the end of 2009 accounted for 339 vessels. The main trawl fleets of GSA 09 are present in the following continental harbours: Viareggio, Livorno, Porto Santo Stefano (Tuscany), Fiumicino, Terracina, Gaeta (Latium). The fishing capacity of the GSA 09 has shown in these last 20 years a progressive decrease; from 1996 to 2010 the number of bottom trawlers of GSA9 decreased of about 30%. Consequently also fishing effort is presumably decreased in this period. In the last five years the total landings of hake of GSA 09 fluctuated between 1000 to about 2300 tons. In 2010 the landing in GSA09 was 1484 tons.

Tab. 6.6.2.1.1 Technical characteristics of the trawl fleet operating in GSA 09.

N. of boats	339
GT	12.484
kW	70.794
Mean GT	36.8
Mean kW	208.8

As concerns fishing activity, the majority of bottom trawlers of GSA 09 operate daily fishing trips with only some vessels staying out for two-three days, especially in summer.

Hake fishing grounds comprise all the soft bottoms of continental shelf and the upper part of continental slope. Fishing pressure shows some geographical differences inside the GSA 09 according to the consistency of the fleets, the distance of fishing grounds from the main ports and the characteristics of the seabed.

The artisanal fleets, according to the 2009 data, accounted for 1,296 vessels that operate in several harbours along the continental and insular coasts. Of these, about 50 vessels, mainly located in some harbors of the GSA 09 (e.g. Marina di Campo, Ponza, Porto Santo Stefano), utilize gillnets and target medium and large-sized hakes (larger than 25 cm TL) especially from winter to summer.

6.6.2.2 Management regulations applicable in 2010 and 2011

- Fishing closure for trawling: 45 days in late summer (not every year have been enforced)
- Minimum landing sizes: EC regulation 1967/2006: 20 cm TL for hake.
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets will be replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.
- Two small No Take Zones (“Zone di Tutela Biologica”, ZTB) are present inside the GSA 09; one off the Giglio Island (50 km^2, northern Tyrrhenian Sea) another off Gaeta, (125 km^2, central Tyrrhenian Sea). Bottom fishing was not allowed in the two ZTB. A recent regulation of the Italian Ministry of Agricultural, Food and Forestry Policies established that fishing activities can be carried out in these two areas from July 1st to December 31st.

6.6.2.3 Catches

6.6.2.3.1 Landings

Landings (t) by year and major gear types, 2002-2010 as reported through DCR.

Table 6.6.2.3.1.1 Landings (t) by year and major gear types, 2004-2010 as reported through DCF. No data for 2002 and 2003 were submitted.

Gear	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Bottom trawls	553	1054	1180	1025	915	853	834
Longlines	4	11	142	16	5	6	1
Miscellaneous	40	20	4				
Nets	596	835	1002	712	410	463	642
Seines	2		3			6	6
Total	**1195**	**1920**	**2330**	**1753**	**1330**	**1329**	**1484**

Trawl landings in GSA 9 are dominated by small sized specimens; they are basically composed by age groups 0+ and 1+. Gillnet fishery lands mostly age 2 and age 3 fish. High quantities of small size hake are routinely discarded, especially in summer and on fishing grounds located near the main nursery areas of the species (Fig. 6.6.2.3.1.1).

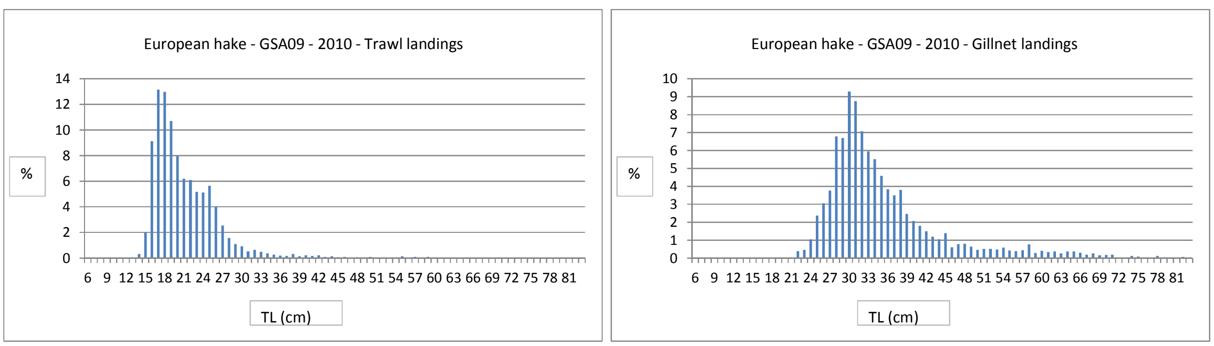


Fig. 6.6.2.3.1.1 Size structure of the landings of hake in 2010 of otter trawling and gillnets in the GSA 09 (DCR official data).

According to the STECF-EWG 11-12 scientist's knowledge, DCF landing data for GSA 09 give an overestimation of the amount derived from the set nets. This aspect underlines both the need of some improvements of the data collection, paying particular attention to the sampling design and the importance of a routinely check made by experts of the official data.

6.6.2.3.2 Discards

Several EU and national projects carried out in GSA 09 highlighted the problem of discard of hake by trawl fisheries. High quantities of small sized hakes are routinely discarded, especially in summer and on the fishing grounds located near the main nursery areas of the species (Fig. 6.6.2.3.2.1).

About 450 and 690 tons of hake discarded by trawl fishery were respectively estimated in 2006 and 2009. In 2010, the discard fraction decreased to 130 tons reflecting the observed decrease in recruitment abundance.

Due to the introduction of the EU Regulations on MLS a progressive increase of the size at which 50% of the specimens caught was discarded has been observed in these last years: from about 11 cm TL in 1995 (Sartor *et al*., 2001b), to about 17 cm TL in 2006 (De Ranieri, 2007). In the last years this size is even increasing (Sartor, pers. obs.) This phenomenon might be also explained with the reduction of the fishing pressure on the nursery areas of this species.

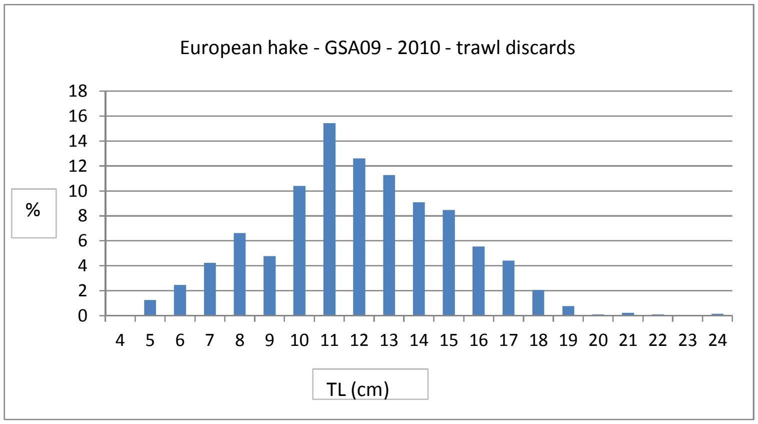


Fig. 6.6.2.3.2.1 Size structure of the hake discarded by the trawl fleets operating in the GSA 09 in 2010 (DCR official data).

Reported discards through the DCR data call to SGMED-09-02 amount 467 t in 2006 for trawlers.

6.6.2.4 Fishing effort

The fishing capacity of the GSA 09 has shown in these last 10 years a progressive reduction; from 1996 to 2010. The total fishing days carried out by all the GSA 09 trawlers decreased from about 65,000 in 2004 to about 63,000 in 2006, also as effect of a reduction from 187 to 177 in the mean number of fishing days/year. The same reduction pattern was observed in the Kw*days at sea either for trawlers (OTB) and fixed nets (GNs and GTR) as showed by Fig. 6.6.2.4.1.

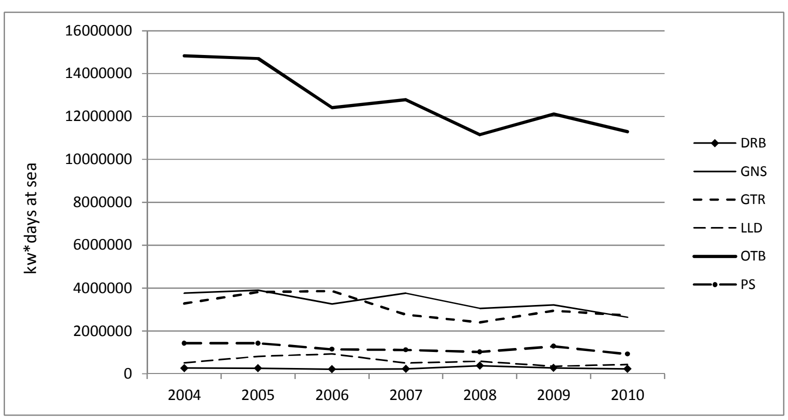


Fig. 6.6.2.4.1 Effort trends (days and kW*days) by major fleets, 2004-2010.

Tab. 6.6.2.4.1 Effort trends (kW*days) by major fleets as reported through DCF (no data available in 2002, 2003).

Type FT - LVL4	2004	2005	2006	2007	2008	2009	2010
GNS	3758318	3902723	3260681	3755597	3054945	3216541	2641506
GTR	3281736	3814641	3861674	2760530	2403569	2948897	2719155
LLD	510386	821542	927993	507078	585762	358051	434722
OTB	14824084	14700599	12404787	12780491	11149391	12107652	11291098
PS	1424338	1426304	1146586	1116579	1017985	1283965	920985

6.6.3 Scientific surveys

6.6.3.1 MEDITS

6.6.3.1.1 Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls were reported per depth stratum (s. Tab. 6.6.3.1.1.1).

Tab. 6.6.3.1.1.1. Number of hauls per year and depth stratum in GSA 09, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA09_010-050	21	20	20	20	21	20	20	19	15	14	15	16	15	15	16	16	15
GSA09_050-100	21	21	20	20	20	21	22	23	17	18	17	16	18	18	16	16	19
GSA09_100-200	38	40	40	40	39	39	38	38	30	30	30	31	29	30	31	31	29
GSA09_200-500	40	40	42	42	41	41	42	41	32	33	36	35	36	37	34	34	35
GSA09_500-800	33	32	31	31	32	32	31	32	26	25	22	22	22	20	23	23	22

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.6.3.1.2 Geographical distribution patterns

According to recent studies (Orsi Relini et al., 2002), the density of hake recruits concentrations in nursery areas in GSA 09 is by far higher than that of the other GSAs of the western Mediterranean and, probably, also of the other Mediterranean GSAs (Fig. 6.6.3.1.2.1).

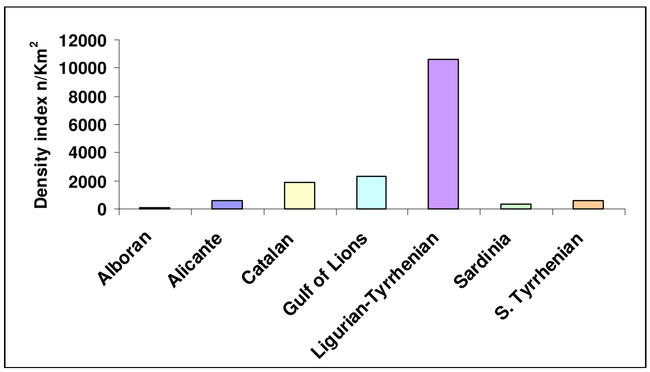


Fig. 6.6.3.1.2.1 MEDITS density indices of the hake recruits (<12 cm TL) obtained in different Mediterranean GSAs (from Orsi-Relini et al., 2002, modified).

Generalized additive models were developed to investigate hake recruitment dynamics in the Tyrrhenian Sea in relation to spawner abundance and selected key oceanographic variables. Thermal anomalies in summer, characterized by high peaks in water temperature, revealed a negative effect on the abundance of recruits in autumn, probably due to a reduction in hake egg and larval survival rate. Recruitment was reduced when elevated sea-surface temperatures were coupled with lower levels of water circulation. Enhanced spring primary production, related to late winter low temperatures could affect water mass productivity in the following months, thus influencing spring recruitment. In the central Tyrrhenian a dome-shaped relationship between wind mixing in early spring and recruitment could be interpreted as an "optimal environmental window" in which intermediate water mixing level played a positive role in phytoplankton displacement, larval feeding rate and appropriate larval drift (Bartolino *et al.*, 2008b) (Fig. 5.7.3.1.2.2).

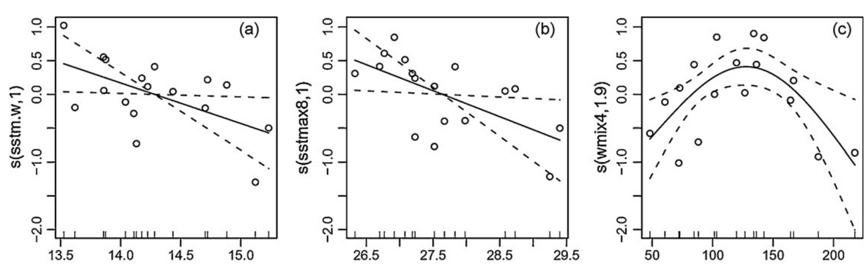


Fig. 6.6.3.1.2.2 Effects of: (a) sstm.w, (b) sstmax8 and (c) wmix4 on hake recruitment in the central Tyrrhenian (from Bartolino et al., 2008b).

The temporal trend in spatial distribution of hake > 26 cm TL showed a clear reduction of distribution area, particularly in the Tyrrhenian part of the GSA (GRUND data, Fig. 6.6.3.1.2.3).

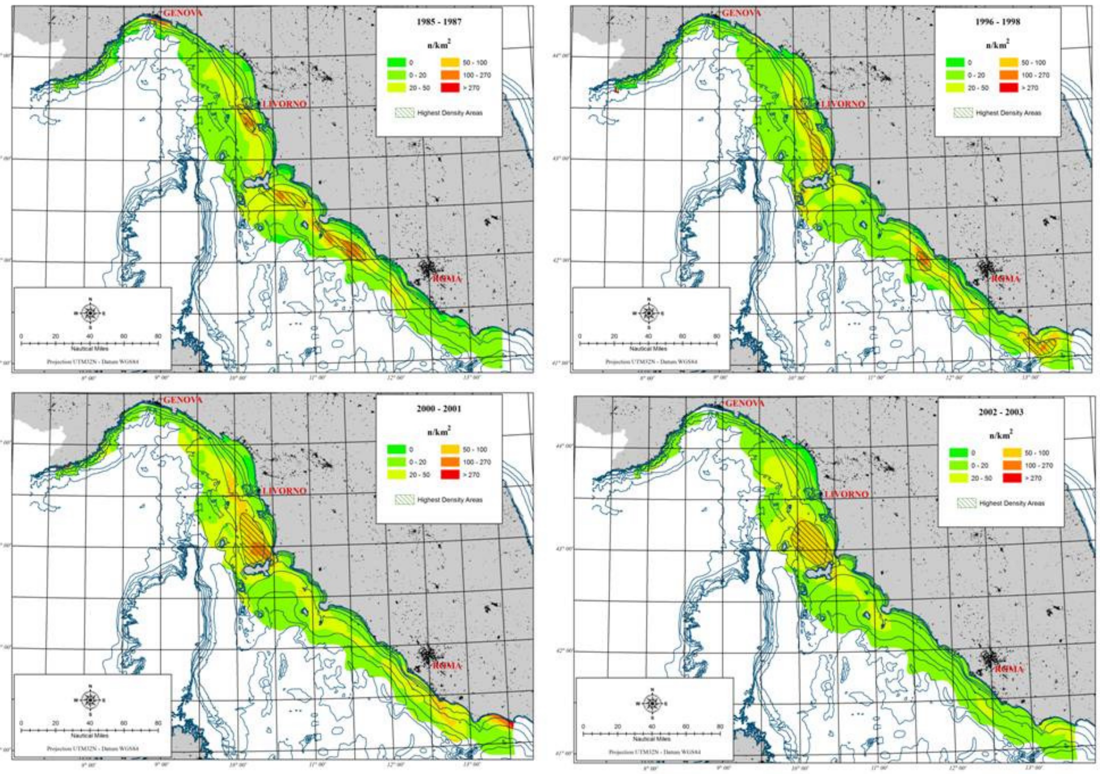
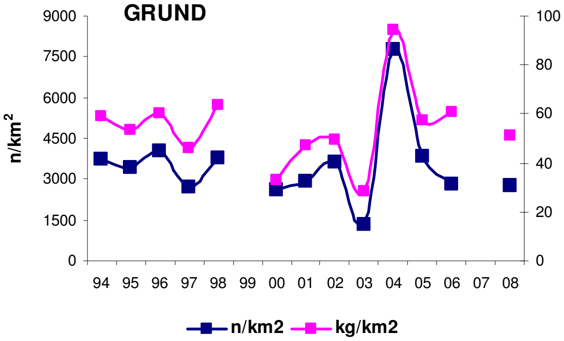


Fig. 6.6.3.1.2.3 Distribution of hakes larger than 26 cm TL in 1985-87, 1996-98, 2000-01, 2002-03.

6.6.3.1.3 Trends in abundance and biomass

The national GRUND trawl survey (Relini, 1998) has been performed out along the Italian coasts in addition to MEDITS. It has been carried out since 1985, with some years lacking (1988, 1989 and 1999, 2007). Sampling is random stratified, except in the period 1990-93 where a different sampling design, based on transects, was applied. Locations of stations were selected randomly within each stratum in the period 1985-87, while starting from 1996, the same stations were sampled the following years. Therefore from 1994 in Italy two trawl surveys are regularly carried out each year: MEDITS, in spring, and GRUND, in autumn. The two surveys provide integrate pictures on different seasons, allowing to monitor the most important biological events (recruitment, spawning) for the majority of the demersal species.

Figure 6.6.3.1.3.1 shows the density and biomass indices of hake obtained from 1994 to 2008; no evident trends are present.



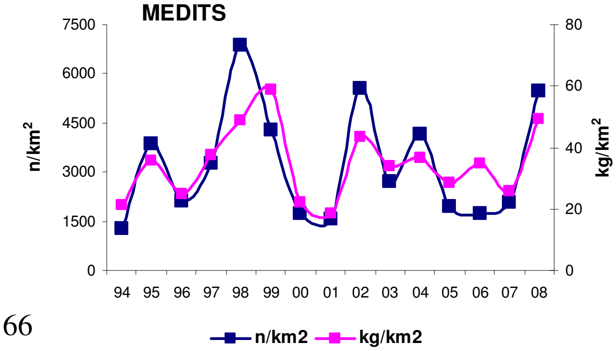


Fig. 6.6.3.1.3.1 Density and biomass indices of hake according to the GRUND and MEDITS surveys.

Figure 6.6.3.1.3.2 displays the re-estimated trend in hake abundance and biomass in GSA 09 (kg/h) based on the MEDITS DCF data call. Both MEDITS trends presented are similar without any trend.

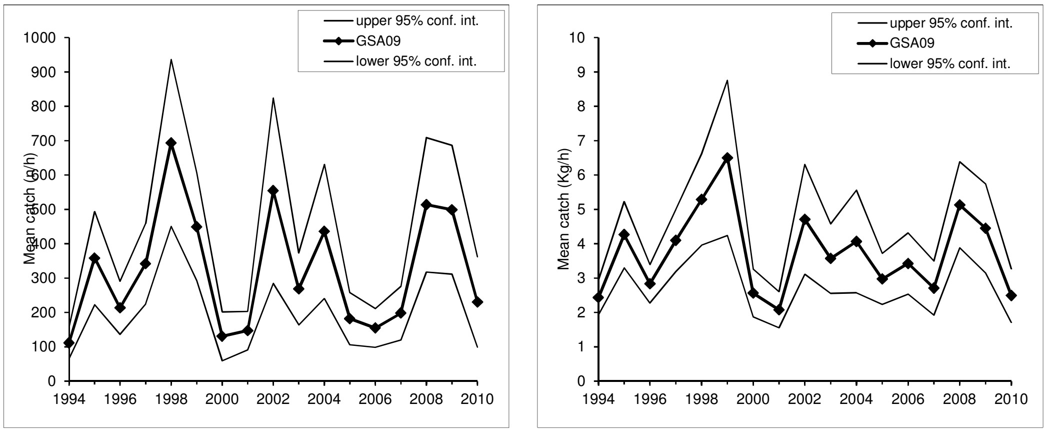


Fig. 6.6.3.1.3.2 Abundance and biomass indices of hake in GSA 09.

6.6.3.1.4 *Trends in abundance by length or age*

The following Fig. 6.6.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in from 1994 to 2010.

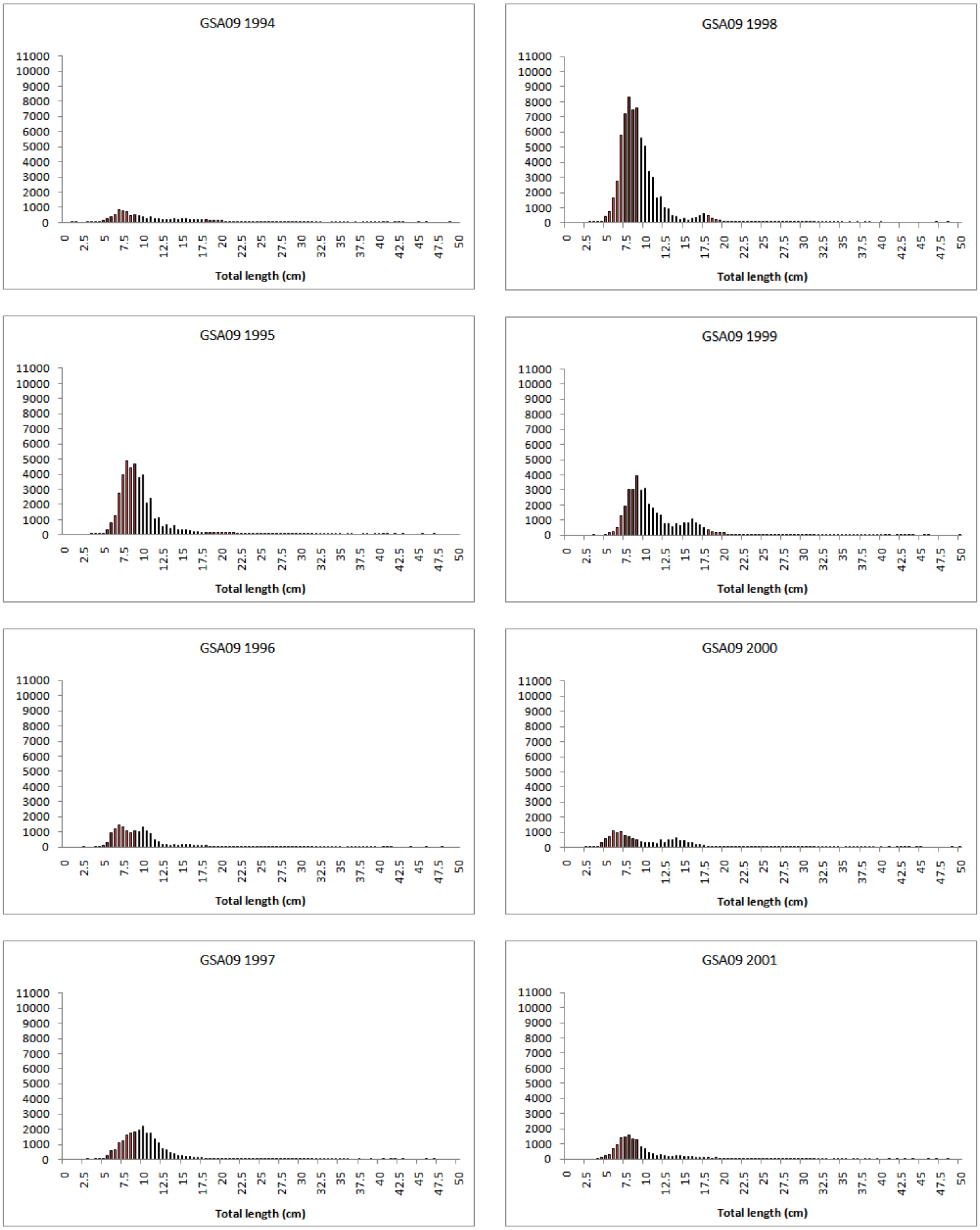
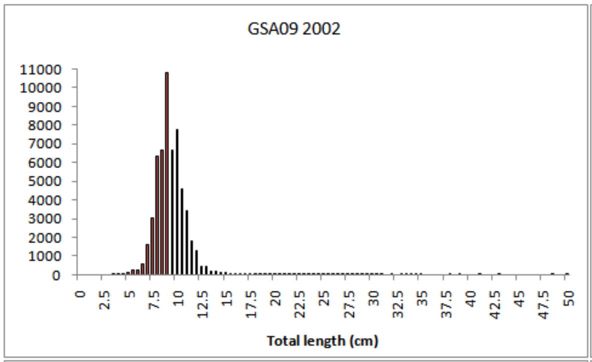
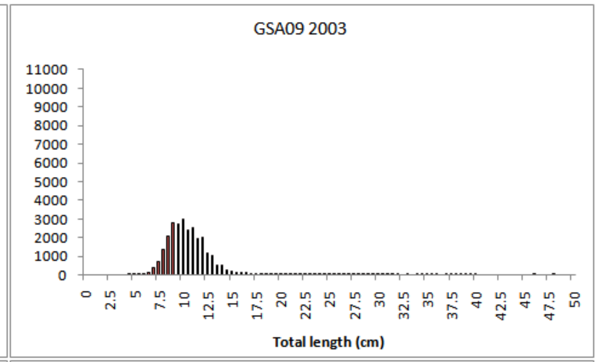
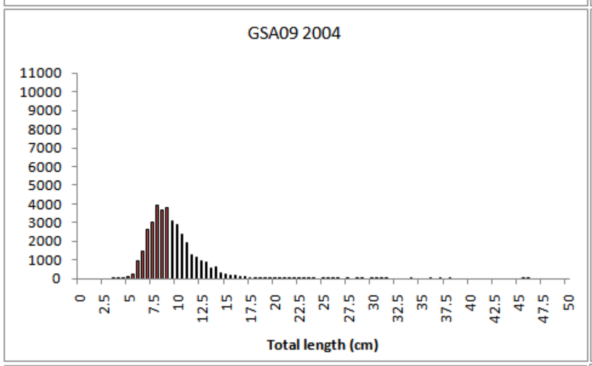
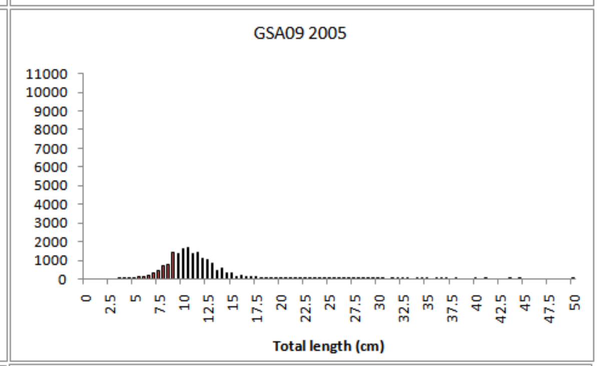


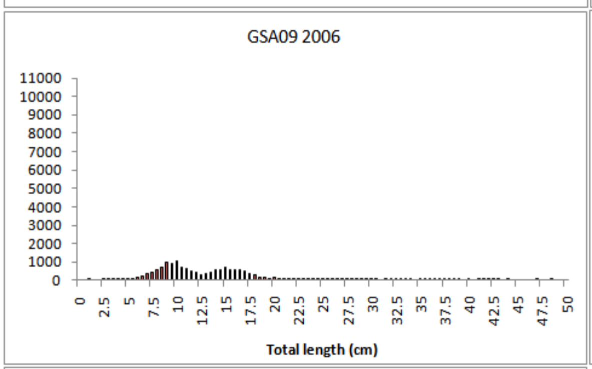
Fig. 6.6.3.1.4.1 Stratified abundance indices by size, 1994-2001.

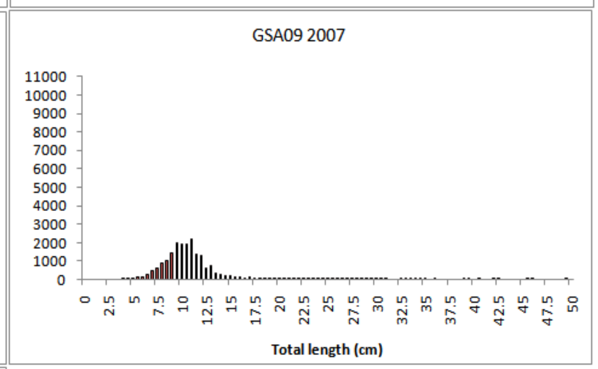

GSA09 2002
11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)

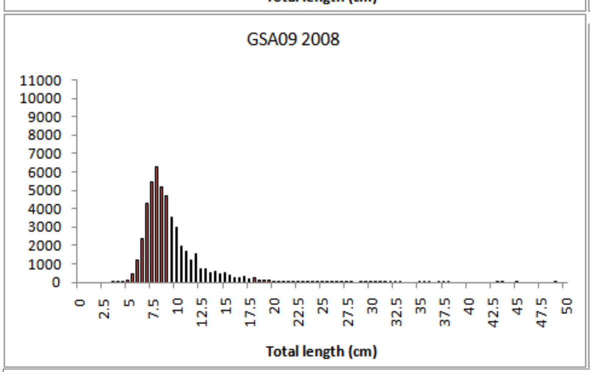

GSA09 2003
11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)

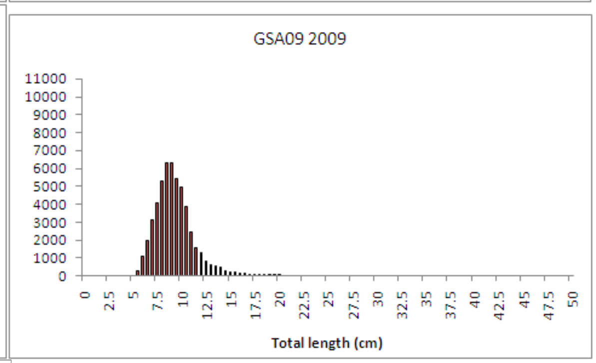

GSA09 2004
11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)


GSA09 2005
11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)


GSA09 2006
11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)


GSA09 2007
11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)


GSA09 2008
11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)


GSA09 2009
11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30 32.5 35 37.5 40 42.5 45 47.5 50
Total length (cm)

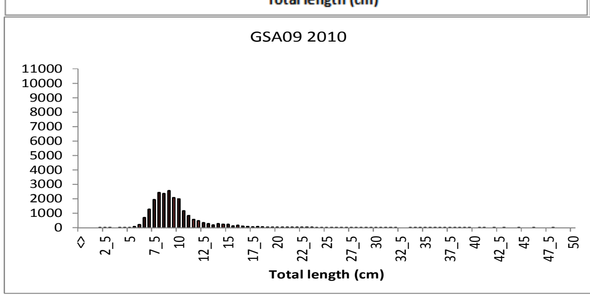

GSA09 2010
11000 10000 9000 8000 7000 6000 5000 4000 3000 2000 1000 0
2_5 5 7_5 10 12_5 15 17_5 20 22_5 25 27_5 30 32_5 35 37_5 40 42_5 45 47_5 50
Total length (cm)

Fig. 5.7.3.1.4.2 Stratified abundance indices by size, 2002-2010.

6.6.3.1.5 Trends in growth

No analyses was conducted during EWG 11-12 meeting.

6.6.3.1.6 Trends in maturity

No analyses was conducted

6.6.4 Assessments of historic stock parameters

Due to its importance as demersal resource, hake has been object of several assessments in the GSA 09 (Reale *et al*., 1995; Fiorentino et al., 1996; Ardizzone et al., 1998; Abella *et al.*, 1999; 2007; Colloca *et al*., 2000). These results are published and regularly updated in the GFCM SAC sheets. The assessments, often performed with different approaches in different periods or in different subareas of the GSA 09, showed substantially convergent results.

The hake in the GSA 09 seems to be in a "chronic" overexploitation, as shown by the results of the analytical models (reference points as F_{max}, $F_{0.1}$ and SSB_{curr}/SSB_0). Also the production models based on total mortality provided total mortality estimates greater than the mortality corresponding to the maximum biological production (ZMBP).

A growth overfishing situation was detected, with excessive fishing mortality on 0+ and 1+ age classes..

Two assessments based on DCF landing data and survey data (MEDITS and GRUND) were produced using Length Cohort Analysis (LCA) and SURBA respectively during STECF-SGMED-09-02. SURBA assessment was updated including 2009 MEDITS data in the time series during STECF-SGMED-10-02. The lack of 2009 landings data for GSA 9 during the meeting makes impossible to perform a new LCA assessment for this stock. In STECF-SGMED-10-03 an XSA assessment was carried using landing data 2005-2009. This assessment was rerun during EWG 11-12 by adding discards in the input data.

6.6.4.1 Method 1: Trends in LPUE

As concerns the Landings per Unit of Effort, quite long time series are available for some important fleets operating in this GSA 09.

6.6.4.1.1 Justification

Trends in LPUE may provide insight into trends in stock size. EWG 11-12 recommends that technological creep should be considered when trends in LPUE are interpreted.

6.6.4.1.2 Input parameters

These data come from independent monitoring activities performed by the research institutes working in the GSA.

6.6.4.1.3 Results

As an example, the LPUE evolution in the period 1991-2008 is reported in Fig. 6.6.4.1.3.1. LPUE showed a continuous decreasing trend till 2004 while LPUE remained substantially stable in the last four years. The decrease in LPUE is mainly due to a change in fishing pattern experienced by the local fleets: the progressive disappearance of the smallest specimens from the landings is the effect of the introduction of the EU Regulations (1626/94 and 1967/06) concerning MLS (20 cm TL for hake). Also a progressive reduction of fishing pressure on the nursery areas is occurring in the last years, especially on the northern fishing grounds of GSA 09.

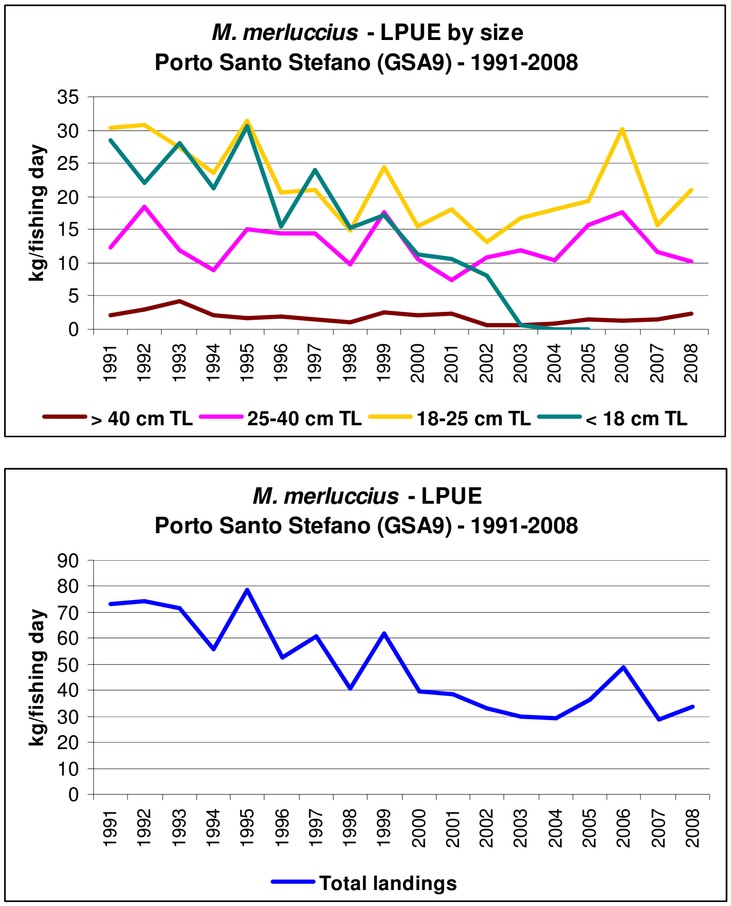


Fig. 6.6.4.1.3.1 Hake LPUE of the Porto Santo Stefano trawl fleet (1991-2008); above: LPUE by size class; below: total LPUE.

6.6.4.2 Method 2: SURBA

6.6.4.2.1 Justification

Trends in LPUE may provide insight into trends in stock size. EWG 11-12 recommends that technological creep should be considered when trends in LPUE are interpreted.

6.6.4.2.2 Input parameters

These data come from independent monitoring activities performed by the research institutes working in the GSA.

The following set of parameters was adopted:

Growth parameters (Von Bertalanffy)
$L\infty$ = 104 (mm, length)
K = 0.2
t_0 = - 0.03
L*W
a = 0.006657
b = 3.028
Natural mortality
M vector Age_1=1.3 , Age_2=0.6, Age_3=0.46, Age_4=0.41, Age_5=0.3
Catchability (q)
q(age 0+) = 0.8, q(age 1+) = 1.0, q(age 2+)=0.7, q(age3+)=0.7, q(age 4+)=0.7
Length at maturity (L50)
L50 = 30 cm
Length of first capture (Lc)
Lc = 12 cm

An improvement of the estimates of catchability of adults is needed to better estimate the stock dynamics and to assess the likely impact of fishing activity on this stock.

Tab. 6.6.4.2.2.1 Input parameters used for the SURBA model.

MEDITS					
Mean abundance					
	Age				
Year	0	1	2	3	4+
1994	2062.6	132.4	5	1.1	1.1
1995	3446.2	159.5	4.3	0.9	0.7
1996	3366.3	80.9	6.3	1.3	0.2
1997	5753.5	86.4	3.3	0.9	0.7
1998	13371	94.8	2.9	1	0.7
1999	7441.3	156.7	9	2.2	0.4
2000	3371	75.3	6.8	1.4	0.5
2001	2663.1	73.8	3.3	2.5	0.7
2002	10864	44.7	2.3	1.7	1.3
2003	5153	82	6	0.5	1.1
2004	7590.5	51.1	1.6	0.6	0.4
2005	3278.9	79.3	3.4	0.5	0.4
2006	2865	114	6.2	1.1	0.4
2007	3559.8	69.1	4.2	2.7	0.2
2008	8529	94.8	3.6	1	1
2009	5121.2	60.855	1.905	0.357	0.1
2010	2042.4	40.801	3.054	0.3665	0.2443
Proportion mature					
	Age				
Year	0	1	2	3	4+
1994	0	0.012	0.96	1	1
1995	0	0.012	0.92	1	1
1996	0	0.029	0.9	1	1
1997	0	0.02	0.94	1	1
1998	0	0.017	0.89	1	1
1999	0	0.015	0.92	1	1
2000	0	0.026	0.92	1	1
2001	0	0.018	0.96	1	1
2002	0	0.028	0.97	1	1
2003	0	0.025	0.93	1	1
2004	0	0.012	0.9	1	1
2005	0	0.027	0.92	1	1
2006	0	0.021	0.93	1	1
2007	0	0.019	0.96	1	1
2008	0	0.019	0.96	1	1
2009	0	0.02	0.94	1	1
2010	0	0.0205	0.94	1	1
Mean weights					
	Age				
Year	0	1	2	3	4+
1994	0.008	0.086	0.498	1.244	3.261
1995	0.006	0.091	0.491	1.205	3.031
1996	0.006	0.103	0.452	1.455	2.122
1997	0.007	0.097	0.519	1.340	2.918
1998	0.005	0.091	0.489	1.509	2.630
1999	0.009	0.090	0.451	1.292	2.036
2000	0.008	0.105	0.475	1.153	2.136
2001	0.006	0.094	0.580	1.180	2.839
2002	0.005	0.114	0.513	1.335	2.522
2003	0.007	0.100	0.509	1.269	2.509
2004	0.006	0.087	0.491	1.345	2.233
2005	0.009	0.101	0.448	1.052	3.447
2006	0.013	0.088	0.505	1.286	3.307
2007	0.007	0.096	0.505	1.286	3.307
2008	0.007	0.096	0.559	1.220	2.000
2009	0.0074	0.0964	0.5593	1.225	1.8109
2010	0.0063	0.0852	0.374	0.665	1.769

6.6.4.2.3 Results

Fitted year effect, that is the model proxy for the combination of fishing effort and mean natural mortality in the underlying population, shows peaks in 1996, 1999, 2003 and 2009. Fitted age effect shows a decreasing from age 0 to age 2, while fitted cohort effects (Figure 6.6.4.2.3.1) show large fluctuations.

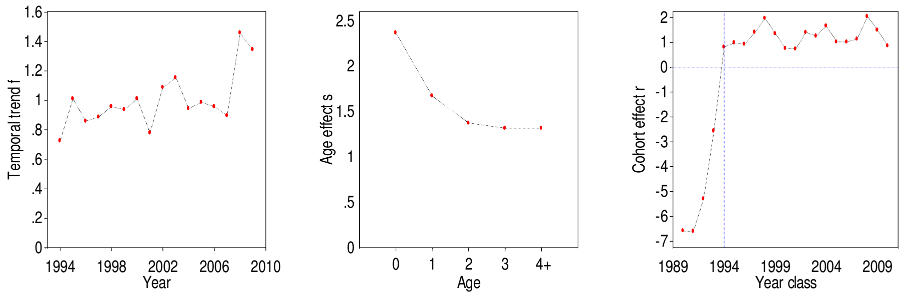


Fig. 6.6.4.2.3.1 MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

F_{1-3} shows a clear increasing trend ($p<0.01$) from 0.8 (1994) to 2.4 (2008), decreasing to 1.77 in 2009. Relative SSB decreased significantly ($p<0.01$) showing the lowest values in 2009-2010. Recruitment fluctuated from year to year without a clear temporal pattern during MEDITS. The largest year classes were observed in 1998 and 2009. A low recruitment index occurred in 2010 (Fig. 6.6.4.2.3.2).

Model diagnostics are shown in the following Fig. 6.6.4.2.3.3 and Fig. 6.6.4.2.3.4.

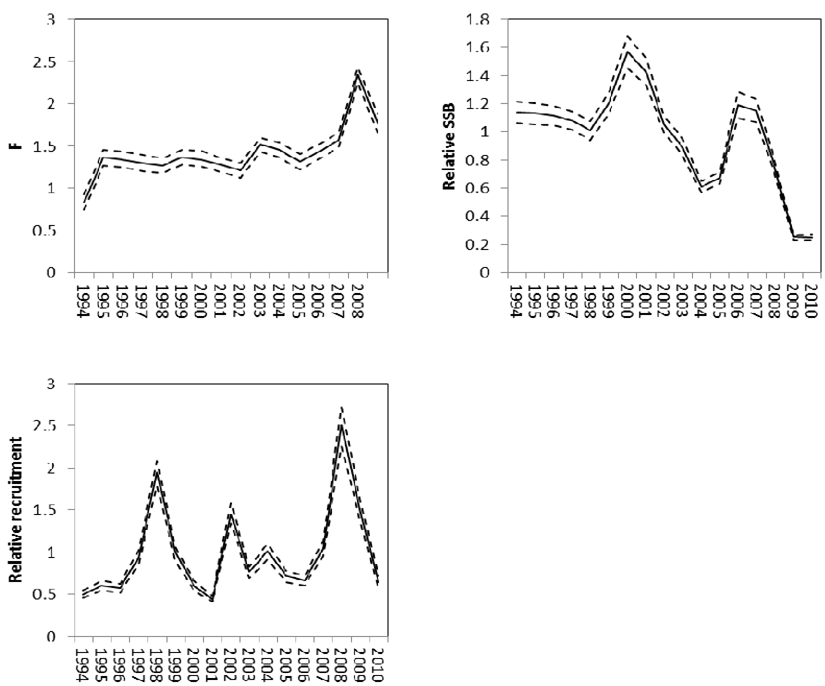
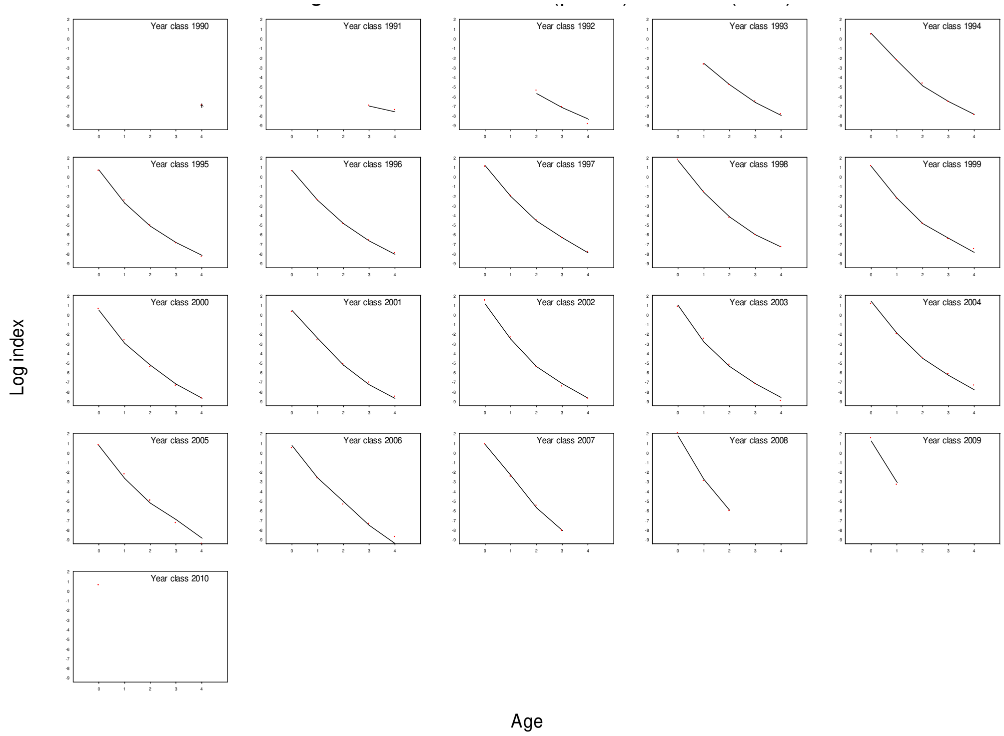


Fig. 6.6.4.2.3.2 MEDITS survey. Estimated trend in F, relative SSB and recruitment using SURBA. 50th percentile of bootstrapped runs (solid line) and 5% and 95% percentiles of bootsrapped runs (dashed lines).



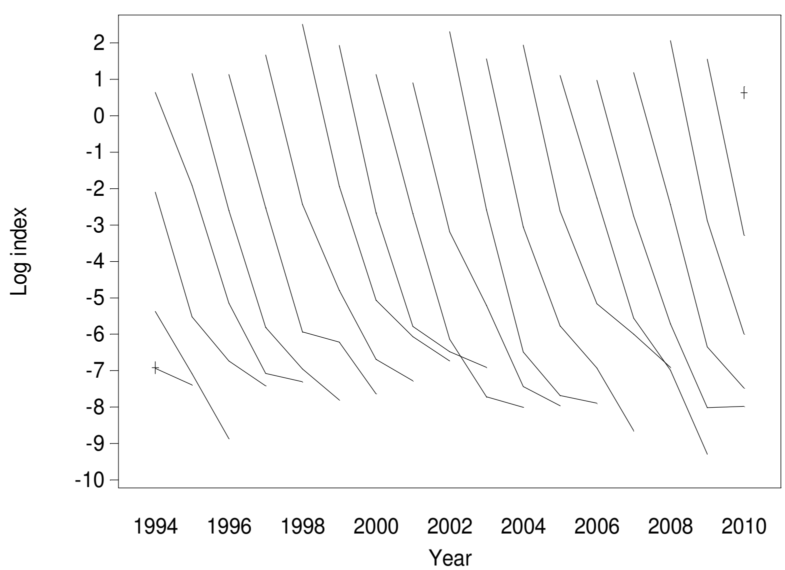


Fig. 6.6.4.2.3.3 Model diagnostic for SURBA model in the GSA 09 (MEDITS data). A) Comparison between observed (points) and fitted (lines) survey abundance indices, for each year. B) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life.

6.6.4.3 Method 3: XSA on DCF data

6.6.4.3.1 Justification

An XSA assessment was carried out during STECF-EWG 11-12 using the catch data collected under DCF from 2005 to 2010 and calibrated with surveys data (MEDITS 2005-2010).

The proportion of trawl discards by age class available for 2006 (450 tons) was used to estimate the discarded fraction in 2007, when the discard sampling was not carried out. Similarly trawl discard data for 2009 (690 tons) were used to calculate catch numbers at age and total catch for 2008.

MEDITS indices for 2005-2010 (see Surba input data) were used as tuning data.

6.6.4.3.2 Input parameters

DCF landing data for hake catch are available for gillnets, trammel nets and trawl fisheries since 2005. Discard data (i.e. annual amount of discards and their size structures) were available for 2006, 2009, 2010. Discard proportion and its age composition estimated for 2006 was applied to calculate catch data for 2005 and 2007 whereas 2009 discard data were used to adjust 2008 landing data. Numbers at age of hake catch, weight at age, mortality at age and maturity at age data were compiled for age groups 1 to 5+ and used as XSA input data for 2005-2010 (Table 6.6.4.3.2.1).

Table 6.6.4.3.2.1 The input parameters to the XSA, i.e. catch at age, weight at age, maturity at age, natural mortality at age.

	Catch-at-age (thousands)					
Age class	2005	2006	2007	2008	2009	2010
1	56407	85166	72515	18677	14276	12051
2	7940	8709	6740	17238	10114	5575
3	509	618	593	626	529	549
4	48	120	34	106	71	129
5+	19	55	5	56	42	97
	Weight-at-age					
Age class	2005	2006	2007	2008	2009	2010
1	0.005685	0.006063	0.005623	0.005434	0.007179	0.02
2	0.103187	0.136246	0.128155	0.121672	0.103433	0.111
3	0.431672	0.611844	0.603328	0.596374	0.453813	0.588
4	1.34	1.369493	1.359158	1.348943	1.36	1.306
5+	2.542673	2.554371	2.530105	2.539243	2.635517	2.34375
	Maturity-at-age					
Age class	2005	2006	2007	2008	2009	2010
1	0	0	0	0	0	0
2	0.21	0.21	0.21	0.21	0.21	0.21
3	0.9	0.9	0.9	0.9	0.9	0.9
4	1	1	1	1	1	1
5+	1	1	1	1	1	1
	Mortality-at-age					
Age class	2005	2006	2007	2008	2009	2010
1	1.3	1.3	1.3	1.3	1.3	1.3
2	0.6	0.6	0.6	0.6	0.6	0.6
3	0.46	0.46	0.46	0.46	0.46	0.46
4	0.41	0.41	0.41	0.41	0.41	0.41
5+	0.25	0.25	0.25	0.25	0.25	0.25

6.6.4.3.3 Results including sensitivity analyses

XSA was run setting shrinkage at 0.5, 1.0, 2.0. As showed by Fig. 6.6.4.3.3.1 the three different settings produced quite similar estimates of recruitment and SSB.

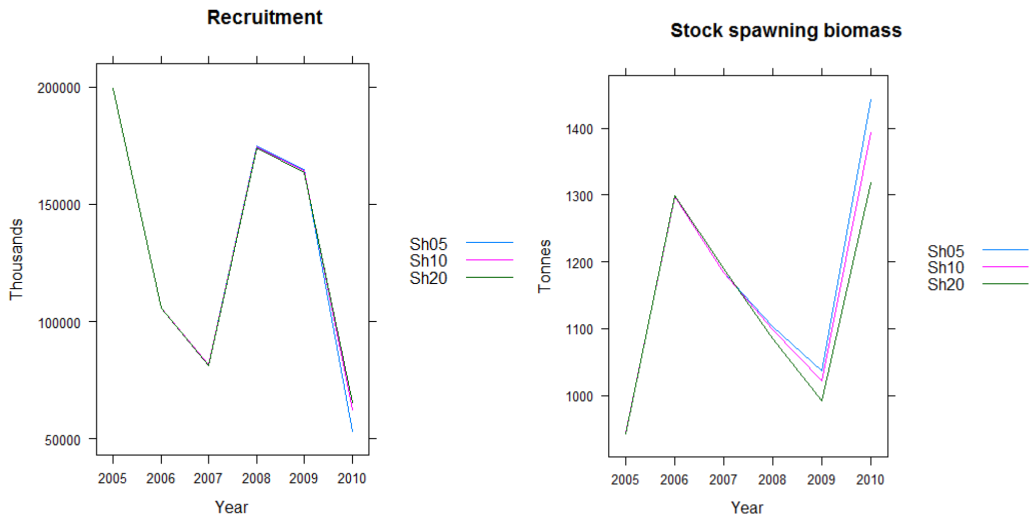


Fig. 6.6.4.3.3.1 Estimates of recruitment and SSB under different shrinkage settings

Model with 2.0 shrinkage was adopted as final model since it produced relatively small residuals, with no clear trend in their distribution (Fig. 6.6.4.3.3.2).

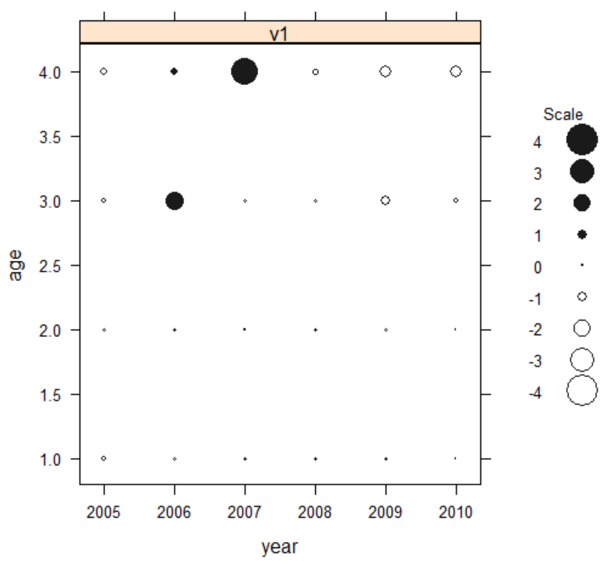


Fig. 6.6.4.3.3.2 Residuals at age obtained with shrinkage set at 2.0 (no shrinkage)

The following Table 6.6.4.3.3.1 lists estimates for spawning stock biomass (SSB), total biomass (TB) recruitment as estimated by XSA from 2005 to 2010. The annual yield including discards is also showed.

During 2005-2010 SSB oscillated between 943.6 and 1443.7 tons (2010), while the total biomass was estimated to be at about 3158-3600 tons.

The largest year classes were observed in 2005 (199.6 millions) and 2008 (174.8 millions), whereas a very low recruitment was estimated in 2010 (52.9 millions) as showed in table 8.4.4.1.4.1. Trend in recruitment from XSA is in line with the MEDITS trend that shows a peak in 2008 and a strong decline in 2010 (see fig. 6.6.4.3.3.3).

Table 6.6.4.3.3.1. Spawning stock biomass (SSB), total biomass (TB) and recruitment estimates by XSA for hake in GSA 9 from 2005 to 2010. Fisheries yield is also indicated

	2005	2006	2007	2008	2009	2010
SSB (tons)	943.59	1298.21	1183.62	1102.98	1037.09	1443.73
TB (tons)	3426.8	3603.1	3211.4	3158.1	3046.5	3427.5
Recruitment (millions)	199.619	105.797	81.547	174.804	164.863	52.981
Yield (including discards)	1923.3	2184.3	1977.9	1795.8	1648.6	1681.3

XSA estimates of F_{bar}2-4 do not appear reliable in the first three years (2005-07) and in particular in 2006 when unrealistic very high values of F at age for age 2-5+ were obtained (Table 8.4.4.1.4.2 and Fig. 5.7.4.2.3.6). In 2008-2010 fishing mortality estimates were more stable with F_{bar}2-4 between 1.4 (2009) and 1.63 (2010). A quite stable trend was obtained for $Fbar_{1-2}$ which ranged between 1.25 (2010) and 1.71 (2008).

Table 6.6.4.3.3.2 Fishing mortality and numbers at age at age as estimated by XSA.

F-at-age

age	2005	2006	2007	2008	2009	2010
1	1.30	0.67	0.68	1.54	1.66	0.43
2	2.07	1.88	2.41	1.95	1.71	2.21
3	1.61	5.26	1.87	1.33	1.19	1.65
4	1.96	3.66	1.76	1.75	1.70	2.13
5+	1.96	3.66	1.76	1.75	1.70	2.13
$Fbar_{2-4}$	**1.88**	**3.60**	**2.02**	**1.67**	**1.53**	**2.00**
$Fbar_{1-2}$	**1.69**	**1.27**	**1.55**	**1.74**	**1.69**	**1.32**

Numbers-at-age (thousands)

age	2005	2006	2007	2008	2009	2010
1	1134.7	640.9	457.7	945.6	1174.8	1307.5
2	1651.7	2020.4	1885.2	1373.2	1063.5	940.4
3	455.3	675.8	751.0	430.3	401.2	587.9
4	105.4	182.9	4.9	163.9	164.4	221.6
5+	79.7	83.2	112.7	245.1	242.7	370.1

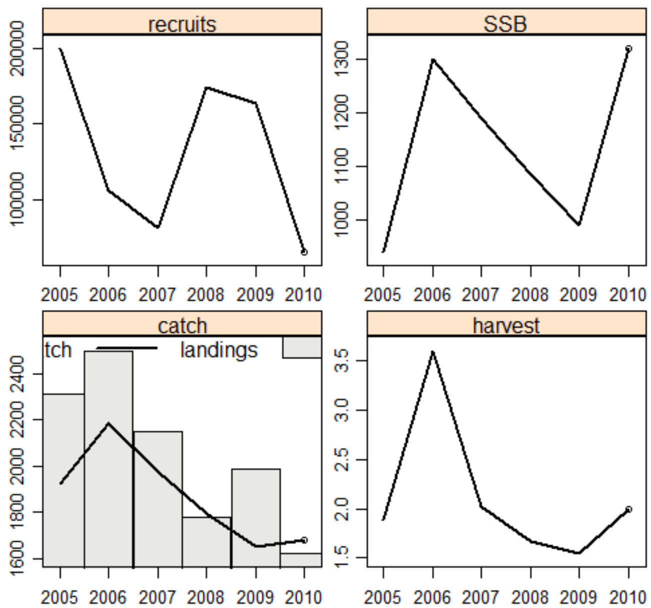


Fig. 6.6.4.3.3.1 Summary of stock parameters (recruitment, SSB, Catch and landing, F mean for ages 2-4) as estimated by XSA.

6.6.5 Long term prediction

6.6.5.1 Justification

Equilibrium YPR reference points for the stock estimated through the Yield software (Hoggarth *et al*., 2006) were assessed.

6.6.5.2 Input parameters

Equilibrium YPR reference points for the stock were estimated through the Yield software (Hoggarth *et al.*, 2006) assuming recruitment fluctuating randomly around a constant value and 20% uncertainty in input parameters. The second YPR analyses used the results of VIT (pseudocohort) as inputs. The used parameters were the same of the SURBA and LCA analyses given above.

6.6.5.3 Results

Yield software quantified uncertainty by repeatedly selecting a set of biological and fishery parameters by sampling from the probability distributions for uncertain parameters set by the user, and then calculating the quantities of interest. In this sampling, it is assumed that each of the uncertain parameters are independently distributed, even though for some biological parameters, this assumption is almost certainly incorrect (Hoggarth *et al*., 2006). F_{max} and F_{ref} , this latter corresponding to F at SSB/initial SSB = 0.30, were assumed as limiting reference points. $F_{0.1}$ was assumed as target reference point. The probability distributions of the three RPs showed a considerable variations (Fig. 6.6.5.3.1). The following mean values were obtained: F_{max} = 0.35; $F_{0.1}$= 0.22 and F_{ref} = 0.28. The maximum predicted values were respectively 0.59 (F_{max}), 0.36 (F_{01}) and 0.41 (F_{ref}). RPs suggest an overfishing situation for the stock considering current F about six times higher than $F_{0.1}$.

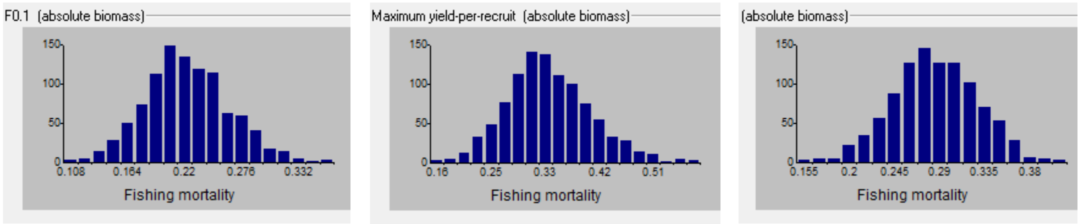


Fig. 6.6.5.3.1 Probability distribution of hake RPs in the GSA 09 obtained using the Yield software (age groups 1-5).

6.6.6 Data quality

Landing and discard data included in the DCF data available during STECF-EGW 11-12 meeting appeared consistent either as landing and discard annual amounts for the fishing gears exploiting the stock (bottom otter trawl, gillnets and trammel nets) or numbers at age and length. It would be however advisable to add in the next DCF also the proportion in the landings of mature fish and the sex ratio by length and age class that were not included in the data available during STECF-EGW 11-12. The proportion of mature fish by length/age class is one of the input required for the assessment. The proportion of mature fish by length/age class is one of the input required for the assessment. The sex ratio it is necessary to evaluate the consistency of the catch at age data provided slicing the length distribution data for the two sexes separately.

6.6.7 Scientific advice

6.6.7.1 Short term considerations

6.6.7.1.1 State of the spawning stock size

Using F at age data and recrutiment estimates as input of aY/R analysis, SSB in 2010 was estimated to be 10-15% of the SSB at F_{msy}. In the absence of any precautionary reference point the STECF EWG 11-12 is unable to fully evaluate the stock size status.

6.6.7.1.2 State of recruitment

Recruitment from 2005 showed a decreasing trend with a lowest value in 2010. The Medits recruitment index shows large fluctuations with any clear trend.

6.6.7.1.3 State of exploitation

The STECF EWG 11-12 proposes $F_{0.1}$=0.2 and limit management reference point consistent with high long term yield and low risk of fisheries collapses. Thus the stock appeared heavily overexploited in 2009-2010 and F needs a consistent reduction from the current F towards the candidate limit reference points for long term sustainability. However, considering the high productivity in terms of incoming year classes, this stock has the potential to increase in size quickly if F is reduced towards F_{msy}. The continued lack of older fish in the surveyed population indicates exploitation rates far beyond those considered consistent with high yields and low risk.

6.7 Stock assessment of red mullet in GSA 09

6.7.1 Stock identification and biological features

6.7.1.1 Stock Identification

Red mullet is distributed along the shelf of all the Mediterranean countries. The species can be found at depths over 200m, but is mainly concentrated in the depth range 0-100m. All the year classes and nursery and spawning areas are well distributed along the narrow Mediterranean shelves. There is not any available definition of unit stocks neither based on genetics, bio-chemistry, fishery-based nor on any method based on somatic features. Under a management point of view, in the frame of GFCM, it has been decided, when the lack of any evidence does not allow suggesting an alternative hypothesis, that inside each one of the GSAs boundaries inhabits a single, homogeneous stock that behaves as a single well-mixed and self-perpetuating population. The GSA boundaries are however arbitrary and certaintly do not take under consideration neither the existence of any local biological feature nor of any difference in the spatial allocation in fishing pressure within it. The hypothesis of a single stock of red mullet in GSA9, which includes waters belonging to 2 seas (Ligurian and Tyrrhenian) separated by the Elba Island and fleets that does not show any spatial overlapping is almost unlikely. The inability to account for spatial structure can lead to uncertainty in the definition of the status of the stocks, due to the possibility of local depletions and to a worse utilization of the potential productivity of the resources.

6.7.1.2 Growth

The species is fast growing, and reaches half of its total size when is one year old. Some light differences in growth speed has been observed within different zones of GSA9. In zones where the species is less exploited, individuals more densely concentrated or available food limited, the mean size of individuals is lower than in other areas of the same GSA were the species is more highly exploited and hence less abundant. In any case, the parameters reported as follows may be considered suitable for the description of an average growth performance valid for the whole GSA9.

Table 1. Common growth parameters considered representative for *M. barbatus* in the GSA9 utilized in the successive analyses.

L_∞=29, K=0.6, t_0=-0.1 L/W relationship a=0.00053 b=3.12

An M vector (age1=1.30, age2 0.79, age 3 0.62, age 4= 0.54) and a weighted mean value of M of 0.65

6.7.1.3 Maturity

The species reaches the sexual maturity at one year old. Observations of proportion of mature individuals by size and analysis with the standard procedure have produced the following sizes at age maturity by sex.

L_m	12.5 cm TL (females) 10 cm TL (males	Sanchez *et al*. 1995

The classical approach for the definition of Lm, as expected, produces a light underestimation of this size. In fact, the bulk of the females spawn at 14 cm.

In GSA9 there have been performed studies on fecundity. The following relationship of fecundity at size (in cm) was defined in the area:

Fecundity = $0.7599 \times TL^{3.336}$

6.7.2 Fisheries

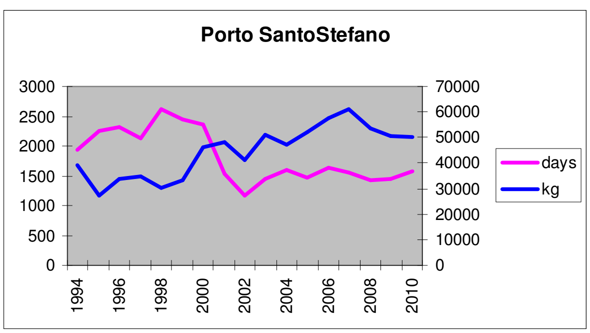
6.7.2.1 General description of fisheries

STECF noted that *Mullus barbatus* is among the most commercially valuable species in the area and is an important component of a species assemblage that is the target of the coastal bottom trawling fleets. It becomes a first order target of part of the fleet in some particular periods when the juveniles of the species are densely concentrated near the coast. The species in GSA9 is mainly caught with three different variants of the Italian bottom trawl net (tartana, volantina and francese). The small mesh size of the cod end in all cases defines a very precocious size/age of first capture.

L_c	7.4 cm TL (males + females)	De Ranieri *et al.*, 2000

Set nets catch modest quantitatives of relatively large individuals, in general over 12 cm TL.

The exerted fishing pressure on this species on different zones of GSA9 is quite variable because conditioned by the structural composition of the fractions of the fleets that operate close to their respective ports, by the bottom characteristics potentially exploitable and also by differences in the fisheries' target among fleets and zones. *Mullus barbatus* catch rates are higher during the post-recruitment period (from September to November). About 200 of the 350 trawlers and a small number of artisanal vessels exploit the species in the GSA9. Annual landings, mostly proceeding from trawling, ranged from 500 to 1100 tons in the last years. Discards of undersized individuals is in general limited (was about 10% in weight in 2006), mainly due to the fact that immediately after recruitment, small-sized individuals, even though potentially vulnerable to the gear, are mostly concentrated inside the 3 miles where trawling practices are forbidden. Illegal catches of juveniles within this stripe, may occur, but can be considered of limited importance.



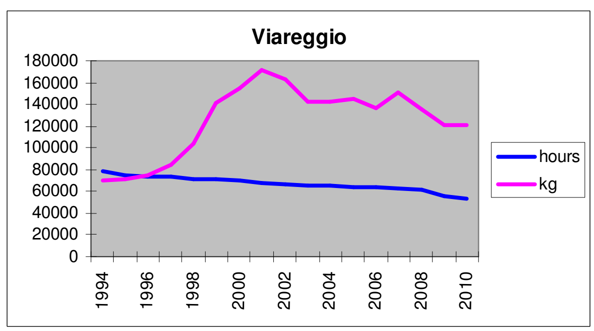


Fig. 6.7.2.1.1 Landings and fishing effort for two important ports of GSA9.

6.7.2.2 Management regulations applicable in 2010 and 2011

Fishing closure for trawling: 45 days in late summer have been enforced certain years for some fleets in GSA9. In 2008 and 2009 was compulsory for all the trawlers in the area.

Minimum landing sizes: EC regulation 1967/2006 defined 12 cm TL as minimum legal landed size for red mullet.

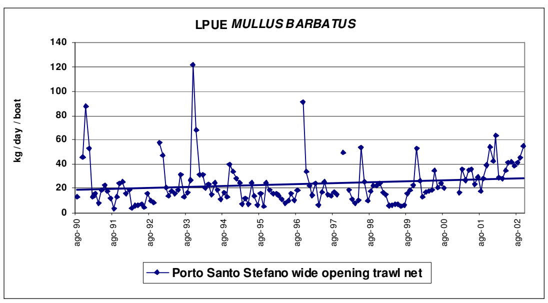
Cod end mesh size of trawl nets: the 40 mm (stretched, diamond meshes) will continue to be utilized up to 30/05/2010. Since 1/6/2010, such cod end will be replaced by a 40 mm square meshes or alternatively by a net with a cod end of 50 mm (stretched) diamond meshes. It is not expected a noticeable increase in the size of entering to the fishery with the introduced changes because this size is only patially defined by the gear but also by the spatial distribution of juveniles.

Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

6.7.2.3 Catches

6.7.2.3.1 Landings

Landings data were reported to SGMED-08-04 through the Data collection regulation and are listed in Table A3.2 of Appendix 3. Since 2002 annual landings varied between 620 and 1,100 t (Tab. 6.7.2.3.1.1). Demersal bottom trawlers dominate the landings by far. Landings size show a very high seasonal variability, with peaks at the end of summer (september) determined by the increase in availability/vulnerability after the massive recruitment on the coastal area.



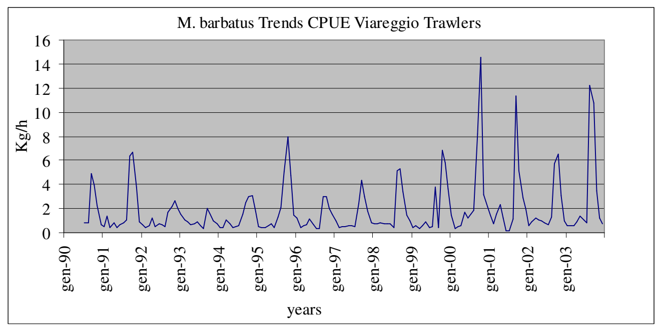


Fig. 6.7.2.3.1.1 Monthly catches with regular seasonal fluctuations in red mullet landings in two of the main ports of GSA9.

Table 6.7.2.3.1.1. Annual landings (t) by fishing technique as reported to SGMED-09-06 through the DCR data call.

Tons			
2010	22.27597	719.64074	44.81494485
UNIT	artisanal	trawl landed	trawl discard

Total 786.7 tons (2010)

2009			
2010	764.4	22.3	786.7

YEAR	Bottom trawls	Nets	Total catch (Tons)
2004	521.1	59.9	583.2
2005	684.0	30.8	714.9
2006	1033.2	16.4	1050.1
2007	1087.4	8.6	1096.0
2008	716.3	11.2	727.4

Table 6.7.2.3.1.2. Annual landings in numbers at length by fishing technique as reported through the DCR data call.

size	artisanal	b.trawl landed	b.trawl discard
0	0.0	0.0	0.0
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	6.6
7	0.0	0.0	10.7
8	0.0	77.7	50.3
9	0.0	422.4	262.8
10	0.0	1217.4	1052.2
11	0.0	1615.0	921.2
12	0.3	2418.1	480.6
13	0.6	2347.7	144.2
14	1.8	2467.4	57.1
15	57.1	2248.2	15.5
16	73.2	1581.8	6.3
17	105.7	1291.1	3.2
18	63.5	908.6	0.0
19	16.2	598.1	0.0
20	25.9	345.6	0.0
21	0.0	186.9	0.0
22	0.0	100.1	0.0
23	5.3	59.7	0.0
24	0.0	32.4	0.0
25	1.2	15.0	0.0
26	0.0	5.0	0.0
27	0.0	2.4	0.0
28	0.0	4.1	0.0
29	0.0	3.1	0.0
30	0.0	2.1	0.0
31	0.0	2.1	0.0
32	0.0	2.1	0.0

Artisanal fisheries target larger individuals, but their landings are small.

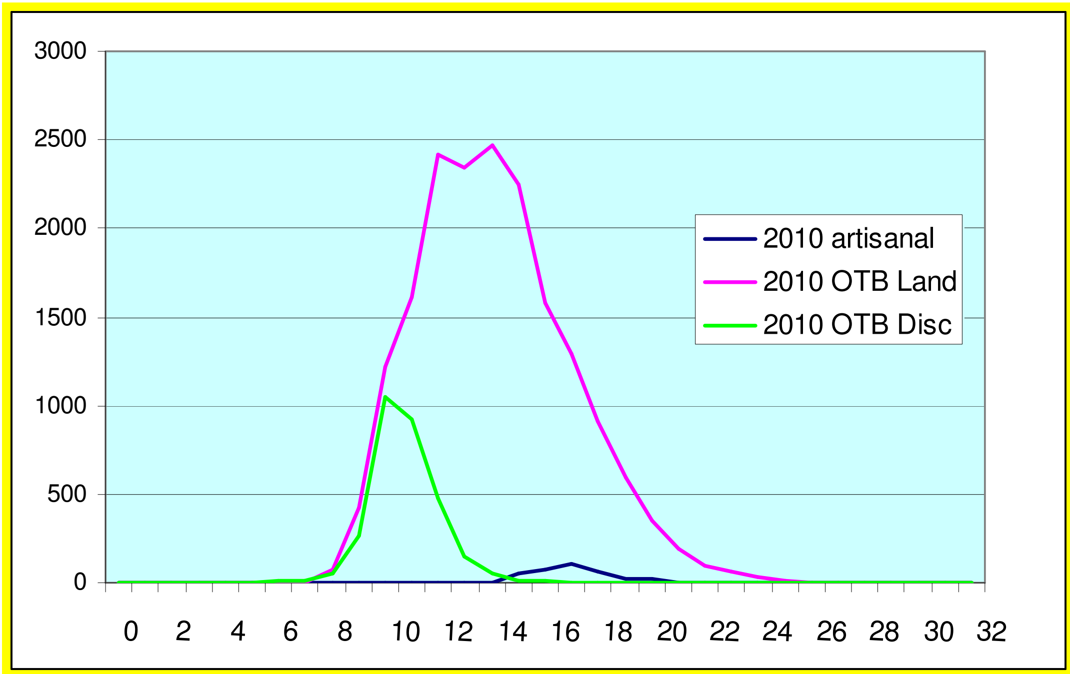


Fig. 6.7.2.3.1.1. Annual landings in numbers at length in 2010 by fishing technique as reported through the DCR data call.

6.7.2.3.2 Discards

Table 6.7.2.3.2.1 Discards in tons.

tons

Artisanal	Trawlers commercial	Trawlers discard
22.27597	719.64074	44.81494485

Discards are only available for bottom trawlers, and was of about 44.8 in 2010. It is likely that no discard occur in artisanal fisheries other than some damaged individuals.

6.7.2.4 Fishing effort

Tab. 6.7.2.4.1 lists the effort by fishing technique deployed in GSA 09 as reported throught the DCR data call. A minor decrease is observed for the main gear demersal otter trawl. It is however difficult to extract from these figures the real number of vessels that target red mullet.

In the last 15 years, a general decrease in the size of the fishing fleets operating in the GSA9 targeting demersal species was observed. The number of vessels targeting the species in question and the changes (reduction) in number along the time interval 1990-2007 is only known for some ports of the GSA. The redction of number of vessels has been particularly important in Porto Santo Stefano fleet (about 50% of reduction) in the South and in Viareggio (about 30%) in the North. It is likely that this general reduction in numbers of vessels also apply for the fraction of the fleet that exert its fishing effort on *M. barbatus* over all the GSA9 fleets. The reduction continued up to 2010.

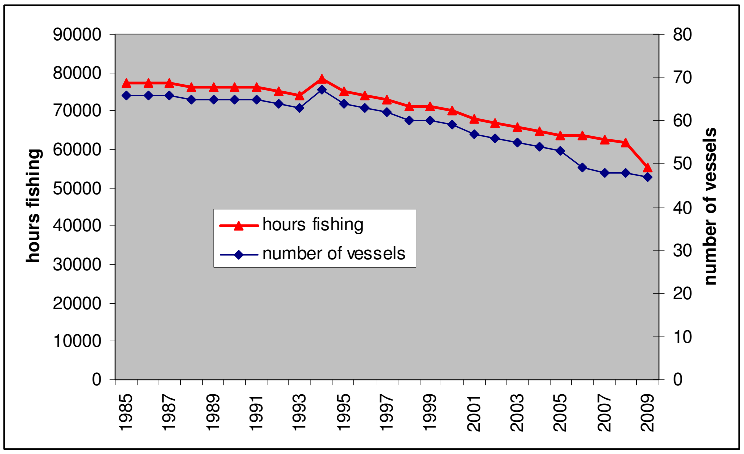


Fig. 6.7.2.4.1 Number of vessels and fishing activity in the port of Viareggio (1990-2010).

Tab. 6.7.2.4.1 Nominal effort (kW days at sea) by fishing technique deployed in GSA 09 as reported throught the DCR data call.

AREA	COUNTRY	GEAR	2004	2005	2006	2007	2008	2009	2010
SA 9	ITA	-1	1497274	1583704	939417	635811	521098	615232	312331
SA 9	ITA	DRB	271337	264317	219582	230204	381592	277250	231746
SA 9	ITA	FPO			1664		25059	9493	9710
SA 9	ITA	GND	15372	4992	62253			4431	17144
SA 9	ITA	GNS	3758318	3902723	3260681	3755597	3054945	3216541	2641506
SA 9	ITA	GTR	3281736	3814641	3861674	2760530	2403569	2948897	2719155
SA 9	ITA	LLD	510386	821542	927993	507078	585762	358051	434722
SA 9	ITA	LLS	433999	495263	383076	112305	31287	31260	20003
SA 9	ITA	LTL			6987	2421		2603	
SA 9	ITA	OTB	14824084	14700599	12404787	12780491	11149391	12107652	11291098
SA 9	ITA	PS	1424338	1426304	1146586	1116579	1017985	1283965	920985
SA 9	ITA	PTB			4599				

6.7.3 Scientific surveys

6.7.3.1 Medits

6.7.3.1.1 Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in this report.

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls considered valid were only used. Valid hauls include the cases of null catches of the species.

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977).(See MEDITS sampling protocol (Bertrand, 2000).

6.7.3.1.2 Geographical distribution patterns

The species is distributed all along the continental shelf of the GSA9, with major abundance in the depth range 0-100m. The species is highly concentrated along the coastal stripe 0-30m when in late summer-beginnings of autumn juveniles massively settle to the bottom. The major nursery areas are allocated in the northern portion of the GSA , Northwards the Elba Island (yellow areas in Fig. 6.7.3.1.2.1).

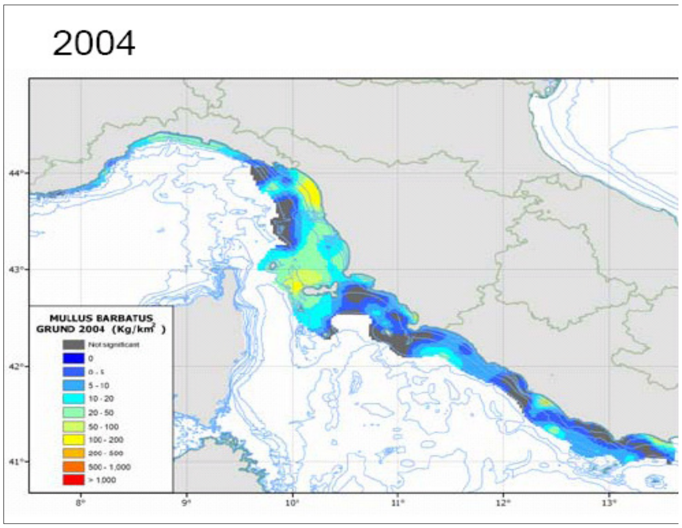


Fig. 6.7.3.1.2.1 Distribution of juveniles of red mullet in autumn 2004 (GRUND survey) in kg/km2

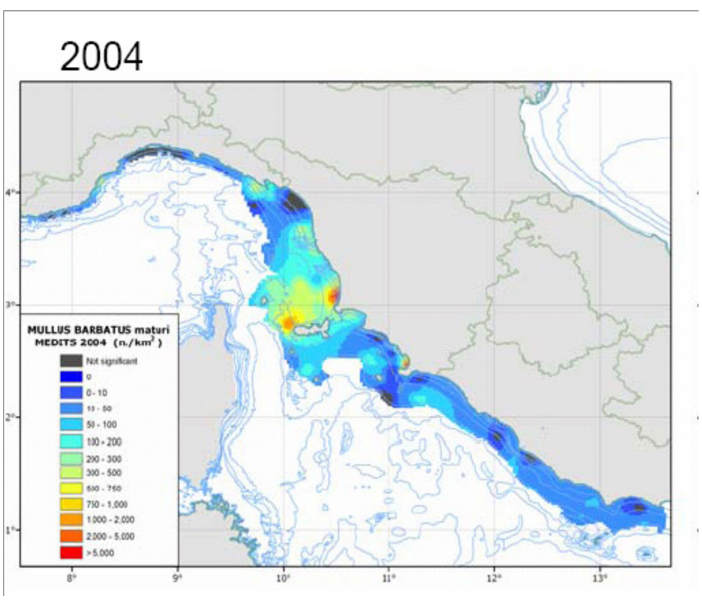


Fig. 6.7.3.1.2.2 Distribution of mature adults of red mullet in spring 2004 (MEDITS survey) in numbers/km2.

Also mature individuals are more abundant in the Northern portion of the GSA 09. The nursery concentrations show a marked spatial stability. Fig. 6.7.3.1.2.3. shows the areas where a major stability along time has been observed (in dark brown)

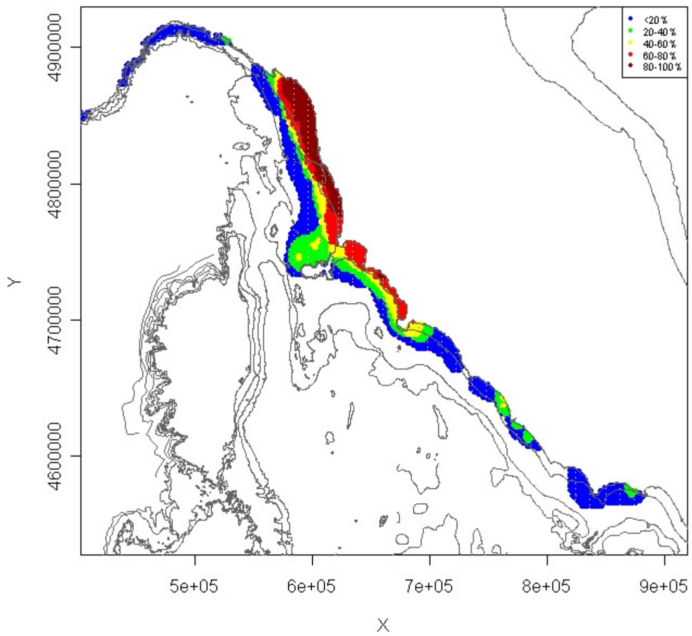


Fig. 6.7.3.1.2.3 Stability of *Mullus barbatus* concentrations

6.7.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 09 was derived from the international survey Medits. Figure 6.7.3.1.3.1 displays the estimated trends in biomass index.

The estimated abundance and biomass indices suggest an increasing trend (from 7.3 to 24 kg/km^2 in 2002, with a more steady situation in the more recent years with values between 15 and 20 kg/km^2.

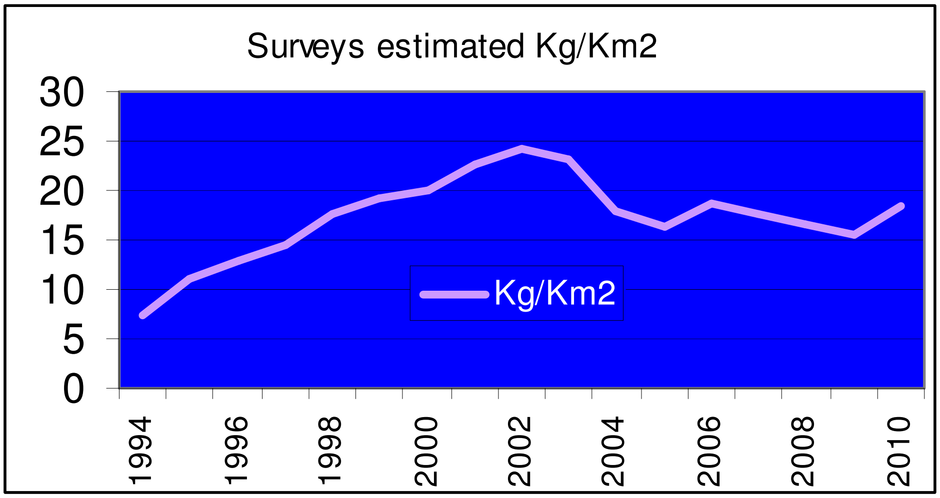


Fig. 6.7.3.1.3.1. Abundance indices derived from MEDITS for red mullet in GSA 09.

6.7.3.1.4 Trends in abundance by length or age

6.7.3.1.5 Trends in growth

No analyses were conducted.

6.7.3.1.6 Trends in maturity

No analyses were conducted.

6.7.4 Assessment of historic stock parameters

6.7.4.1 Method 1: Stock-Production model

6.7.4.1.1 Justification

The analysis was performed using the ASPIC.5.3 software (A Stock-Production model Incorporating Covariates) (Prager, 1994, 2005) assuming a Schaefer (1954) model. This program implements a non-equilibrium, continuous-time, observation-error estimator for the dynamic production model (Schnute, 1977; Prager, 1994). The model was used to estimate K, MSY, the ratios of both current biomass or F to the biomass or F at which MSY can be attained, and q (the catchability coefficient, the proportion of total stock removed by one unit of fishing effort).

6.7.4.1.2 Input parameters

Input data consist in 2 sets of time series of total landings (in kg) and fishing effort expressed as kg/hour and kg/day for two of the main ports of the GSA9 (Viareggio and Porto Santo Stefano) which are considered representative for the area and a time series of an index of abundance (kg/km2) for the whole GSA9 derived from MEDITS surveys. The possibility of using at the same time several data sets is a new extension incorporated in ASPIC new versions.

6.7.4.1.3 Results

The length cohort analysis allowed the estimation of the current fishing mortality rate. The approach was implemented on a Excel spreadsheet. The annual catch by size was used in order to derive an *F* vector and mean numbers by size.

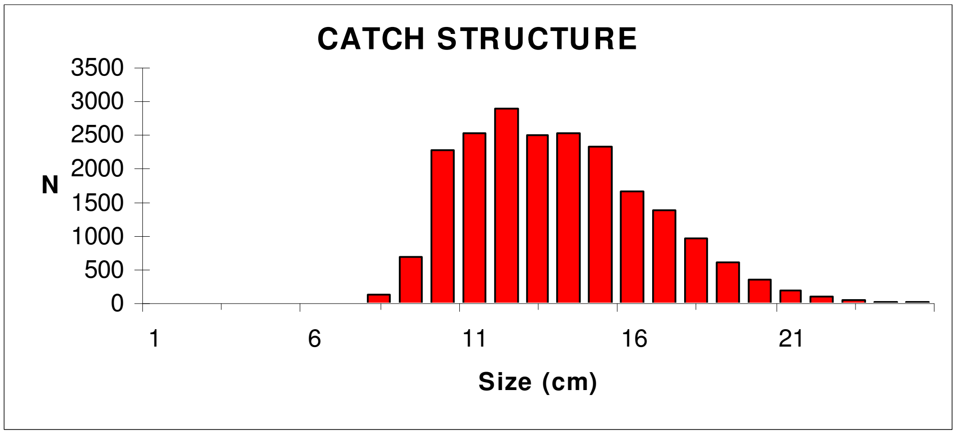


Fig. 6.7.4.1.3.1 Size structure of the catch of *Mullus barbatus* using both artisanal gears and bottom trawl nets (the distribution includes discards)

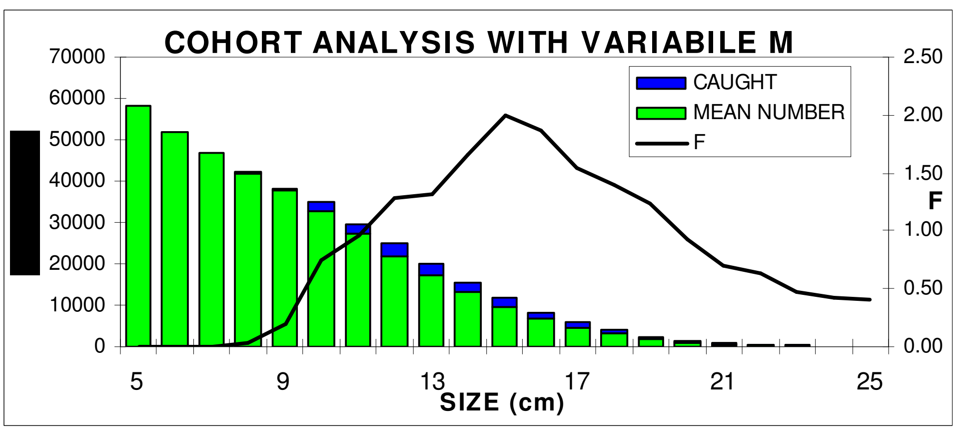


Fig. 6.7.4.1.3.2 Numbers caught and stock numbers at length as well as fishing mortality F at length.

Tab. 6.7.4.1.3.1 Numbers at sea, catch and *F* at size year 2010.

	Prop matur	B year	SSB	total F	ind W	N	C OTB l	C OTB (	C GTR	F OTB land	F OTB disc	F GTR
age												
0	0.00	1739438	0	0.28	2.5	701250	3332	2304	0	0.16	0.11	0.000
1	0.99	2706776	2677001	1.58	30.6	88527	13263	707	302	1.47	0.08	0.033
2	1.00	379915	379915	0.95	86.9	4371	1131	0	42	0.92	0.00	0.034
3	1.00	97584	97584	0.81	129.6	753	160	0	5	0.78	0.00	0.026
4	1.00	22922	22922	0.43	161.4	142	32	0	0	0.43	0.00	0.000
5	1.00	10273	10273	0.40	183.4	56	15	0	1	0.37	0.00	0.029

Maturity at age, Spawning stock biomass, Numbers at age, Discards, F vectors, derived from LCA

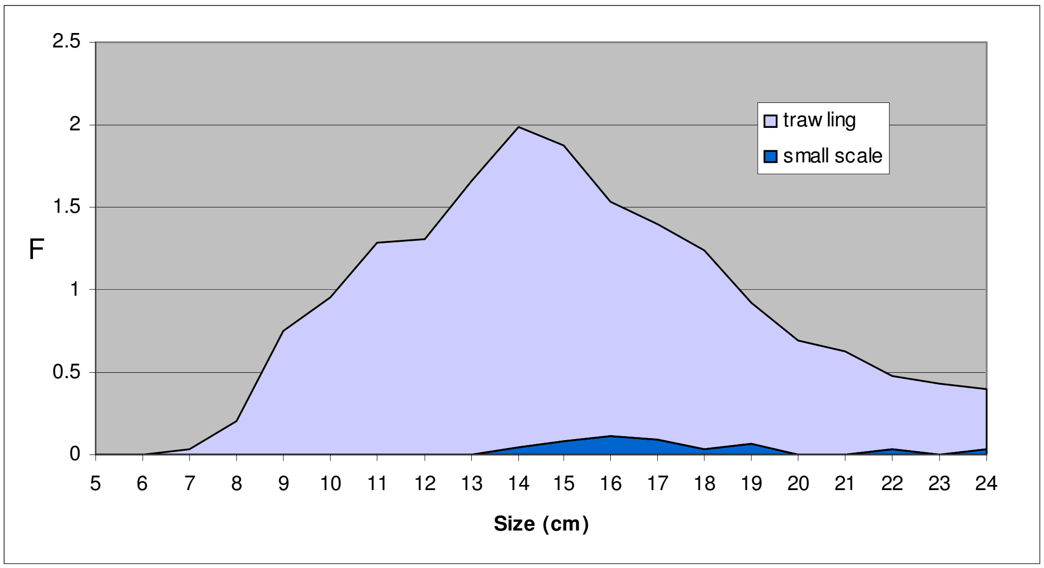


Fig. 6.7.4.1.3.3 Fraction of fishing mortality rate produced by trawling and small scale fisheries

6.7.4.2 Method 2: ASPIC -- A Surplus-Production Model Including Covariates (Ver. 5.33)

6.7.4.2.1 Justification

Model Author: Michael H. Prager; NOAA Center for Coastal Fisheries and Habitat Research

LOGISTIC model mode, YLD conditioning, SSE optimization

Reference: Prager, M. H. 1994. A suite of extensions to a nonequilibrium surplus-production model. Fishery Bulletin 92: 374-389

6.7.4.2.2 Data input

PORTO SANTO STEFANO			
year	days	kg	KG/day
1994	1928	39029	20.2
1995	2250	27357	12.2
1996	2320	33643	14.5
1997	2137	34715	16.2
1998	2626	30091	11.5
1999	2454	33161	13.5
2000	2354	46063	19.6
2001	1532	48069	31.4
2002	1174	40993	34.9
2003	1448	51027	35.2
2004	1591	46948	29.5
2005	1475	51949	35.2
2006	1629	57511	35.3
2007	1550	60936	39.3
2008	1423	53411	37.5
2009	1449	50396	34.8
2010	1576	50176	31.8

VIAREGGIO			
year	hours	kg	kg/h
1994	78375	69650	0.9
1995	75240	71340	0.9
1996	74195	74663	1.0
1997	73150	85110	1.2
1998	71060	104051	1.5
1999	71060	141873	2.0
2000	70015	154654	2.2
2001	67925	170953	2.5
2002	66880	163647	2.4
2003	65835	143018	2.2
2004	64790	142679	2.2
2005	63745	144629	2.3
2006	63556	137005	2.2
2007	62630	150682	2.4
2008	61726	135800	2.2
2009	55403	120991	2.2
2010	53187	120734	2.3

SURVEY ABBUND INDEX	
year	Kg/Km2
1994	7.4
1995	11.0
1996	13.0
1997	14.6
1998	17.6
1999	19.3
2000	19.9
2001	22.5
2002	24.2
2003	23.0
2004	17.9
2005	16.4
2006	18.8
2007	17.8
2008	16.6
2009	15.5
2010	18.4

6.7.4.2.3 Results

```
CONTROL PARAMETERS (FROM INPUT FILE)                Input file: c:\nft\aspic5\mba 2 fisheries
------------------------------------------------------------------------------------------------------------------------
Operation of ASPIC:  Fit logistic (Schaefer) model by direct optimization.
Number of years analyzed:                17          Number of bootstrap trials:              0
Number of data series:                   3          Bounds on MSY (min, max):      1.500E+05     1.000E+06
Objective function:             Least squares       Bounds on K (min, max):        4.000E+05     1.000E+07
Relative conv. criterion (simplex):   1.000E-08     Monte Carlo search mode, trials:    0       50000
Relative conv. criterion (restart):   3.000E-08     Random number seed:                 657438223
Relative conv. criterion (effort):    1.000E-04     Identical convergences required in fitting:     6
Maximum F allowed in fitting:            3.000
```

MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)

```
------------------------------------------------------------------------------------------------------------------------
Parameter                              Estimate    User/pgm guess    2nd guess    Estimated    User guess

B1/K    Starting relative biomass (in 1994)     1.130E-01       4.000E-01       5.604E-01
MSY     Maximum sustainable yield               2.745E+05       3.500E+05       3.200E+05
K       Maximum population size                 1.157E+06       2.500E+06       8.658E+05
phi     Shape of production curve (Bmsy/K)      0.5000          0.5000          ----
```

```
MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
------------------------------------------------------------------------------------------------------------------------
Parameter                              Estimate          Logistic formula        General formula

MSY     Maximum sustainable yield          2.745E+05              ----                  ----
Bmsy    Stock biomass giving MSY           5.787E+05              K/2               K*n**(1/(1-n))
Fmsy    Fishing mortality rate at MSY      4.744E-01           MSY/Bmsy               MSY/Bmsy

n       Exponent in production function    2.0000                 ----                  ----
g       Fletcher's gamma                   4.000E+00              ----         [n**(n/(n-1))]/[n-1]
```

B./Bmsy	Ratio: B(2011)/Bmsy	5.842E-01	----	----
F./Fmsy	Ratio: F(2010)/Fmsy	1.143E+00	----	----
Fmsy/F.	Ratio: Fmsy/F(2010)	8.750E-01	----	----

Y.(Fmsy) Approx. yield available at Fmsy in 2011 1.604E+05 MSY*B./Bmsy MSY*B./Bmsy
...as proportion of MSY 5.842E-01 ---- ----
Ye. Equilibrium yield available in 2011 2.271E+05 4*MSY*(B/K-(B/K)**2) g*MSY*(B/K-(B/K)**n)
...as proportion of MSY 8.272E-01 ---- ----

--------- Fishing effort rate at MSY in units of each CE or CC series ---------

fmsy(1)	Series 1	4.643E+03	Fmsy/q(1)	Fmsy/q(1)
fmsy(2)	Series 2	5.930E+04	Fmsy/q(2)	Fmsy/q(2)

ESTIMATED POPULATION TRAJECTORY (NON-BOOTSTRAPPED)

Obs	Year or ID	Estimated total F mort	Estimated starting biomass	Estimated average biomass	Observed total yield	Model total yield	Estimated surplus production	Ratio of F mort to Fmsy	Ratio of biomass to Bmsy
1	1994	0.824	1.308E+05	1.319E+05	1.087E+05	1.087E+05	1.109E+05	1.736E+00	2.260E-01
2	1995	0.689	1.330E+05	1.431E+05	9.868E+04	9.868E+04	1.190E+05	1.453E+00	2.299E-01
3	1996	0.649	1.533E+05	1.668E+05	1.083E+05	1.083E+05	1.354E+05	1.369E+00	2.649E-01
4	1997	0.604	1.804E+05	1.984E+05	1.198E+05	1.198E+05	1.559E+05	1.273E+00	3.118E-01
5	1998	0.560	2.165E+05	2.394E+05	1.341E+05	1.341E+05	1.800E+05	1.181E+00	3.740E-01
6	1999	0.638	2.623E+05	2.744E+05	1.750E+05	1.750E+05	1.986E+05	1.345E+00	4.533E-01
7	2000	0.696	2.858E+05	2.883E+05	2.007E+05	2.007E+05	2.054E+05	1.468E+00	4.939E-01
8	2001	0.778	2.905E+05	2.817E+05	2.190E+05	2.190E+05	2.022E+05	1.639E+00	5.020E-01
9	2002	0.760	2.737E+05	2.691E+05	2.046E+05	2.046E+05	1.960E+05	1.603E+00	4.729E-01
10	2003	0.733	2.650E+05	2.648E+05	1.940E+05	1.940E+05	1.938E+05	1.544E+00	4.579E-01
11	2004	0.704	2.647E+05	2.682E+05	1.887E+05	1.887E+05	1.955E+05	1.483E+00	4.574E-01
12	2005	0.723	2.715E+05	2.719E+05	1.966E+05	1.966E+05	1.974E+05	1.524E+00	4.691E-01
13	2006	0.709	2.723E+05	2.744E+05	1.945E+05	1.945E+05	1.986E+05	1.494E+00	4.705E-01
14	2007	0.790	2.764E+05	2.678E+05	2.116E+05	2.116E+05	1.953E+05	1.666E+00	4.775E-01
15	2008	0.724	2.600E+05	2.615E+05	1.892E+05	1.892E+05	1.920E+05	1.525E+00	4.493E-01
16	2009	0.618	2.628E+05	2.775E+05	1.714E+05	1.714E+05	2.001E+05	1.302E+00	4.542E-01
17	2010	0.542	2.915E+05	3.152E+05	1.709E+05	1.709E+05	2.175E+05	1.143E+00	5.038E-01
18	2011		3.381E+05				5.842E-01		

MAIN ASPIC RESULTS

Current F estimated with ASPIC		0.54
Fmsy	Fishing mortality rate at MSY	0.474
B./Bmsy	Ratio: B(2010)/Bmsy	0.584
F./Fmsy	Ratio: F(2010)/Fmsy	1.14 (1.138 in 2009)

The results of the Biomass Dynamic Model suggest that the stock, if effort is kept at the current levels or lower, is shifting towards a more optimal exploitation status. The *F* estimated for the last year is not much higher than F_{MSY} level (current F_{curr}/F_{MSY}=1.14), but with the ratio B_{curr}/B_{MSY} still well below 1 (B_{2010}/B_{MSY}=0.58), but showing an increasing trend.

Data of abundance index of Porto Santo Stefano have shown a lightly lower correlation with surveys data, probably due to the fact that in this port, the fleet has a different spatial behavior (they often operate at higher depth) and *Mullus barbatus* is not a prioritary commercial species.

Fig. 6.7.4.2.3.1 shows the light increase in the last years of the level of biomass while *F* decreased since 2007 and particularly in the last years.

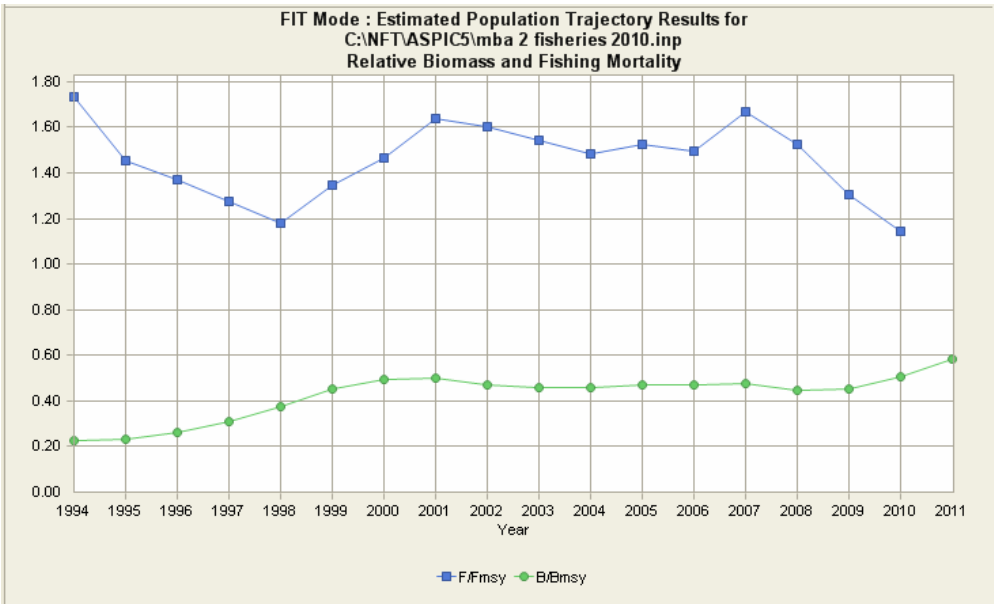


Fig Fig. 6.7.4.2.3.1 Historic trend in estimated fishing mortality as F/F_{MSY} ratio (upper panel) and biomass as B/B_{MSY} ratio (lower panel).

6.7.5 *Short term prediction*

Short term prediction of stock size and catch under different management scenarios will be accomplished during the follow up meeting STECF EWG 11-20, 16-20 January 2012.

6.7.6 *Medium term prediction*

Will be accomplished during the follow up meeting STECF EWG 11-20, 16-20 January 2012.

6.7.7 *Long term prediction*

6.7.7.1 Justification

A Y/R Thompson & Bell type analysis was performed with the “YPR” software of the NOAA stock assessment toolbox. A weighted average value was used in input. All the analysis were performed as a per-recruit basis, assuming recruitment constant with only a random fluctuation.

6.7.7.2 Input parameters

There were used the growth and L/W parameters defined above. A weighted mean value of M of 0.6 was used instead of an M-at-size vector.

6.7.7.3 Results

Values of Fmax =1.02 and $F_{0.1}$ =0.48 were estimated and the F rate at which the spawning biomass is expected to be reduced to 40% of the pristine Biomass (F40%SSB) was estimated as 0.63

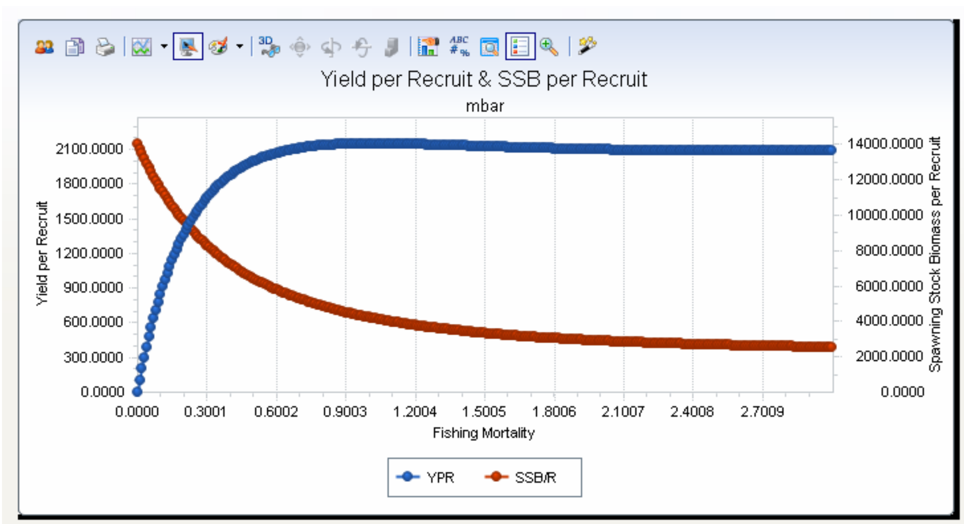


Fig. 6.7.7.3.1 Yield and Spawning Stock Biomass per recruit.

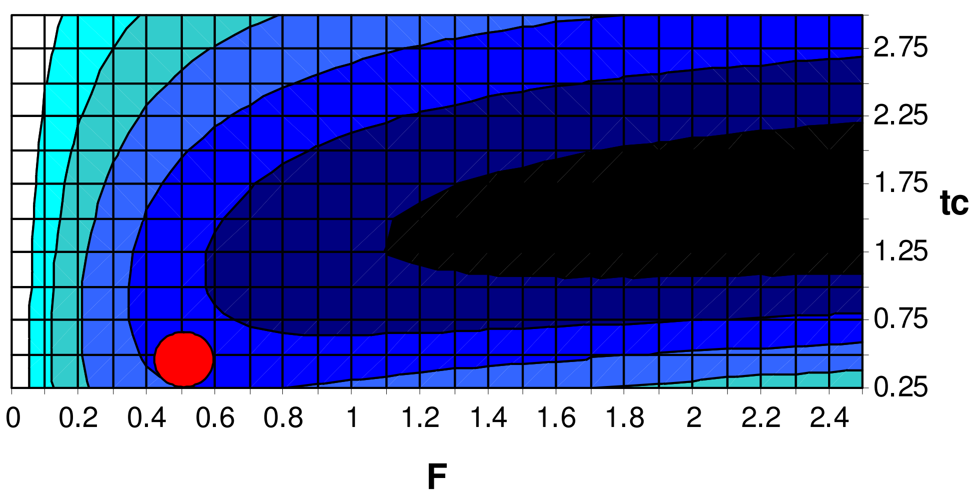


Fig. 6.7.7.3.2 Yield-per-Recruit isoplets. The red circle represents the current combination of F and tc.

6.7.8 Data quality

The available data from both fisheries dependent and fisheries independent sources available is considered good enough in order to perform a reliable assessment of the stock. However, the species dynamics (fast growth, presence of a reduced number of cohorts, the lacking of a good knowledge on the relationship stock/recruitment, the objective difficulties for ageing, the lacking of a long enough time series of data on demographic structure of the commercial catches) makes justified the current use of a non-equilibrium production model. However, there are enough data to run an XSA and compare the results against the current production model.

Still remains unsolved the issue of unit stocks definition inside the GSA9, which boundaries have been defined arbitrarily. In fact, the GSA is divided in two portions, separated by the geographic barrier represented by the Elba island, with the northern portion located in the Ligurian Sea, and the southern one in the Tyrrhenian sea. Considering the sedentary behaviour of the species, that only shows ontogenetic migrations from the shore towards deeper waters, it is likely that the status of the stock in relatively small areas along the coast, will mainly depend on the fishing pressure exerted on them by the local fleets, and will not be influenced by what happens in other neighboring areas, that can be exploited at quite different rates by other fleets. The pooling of the data coming from heterogeneous sub-areas characterized by different levels of abundance and demographic structure, can lead to uncertainty in the definition of the status of the stocks, and such merging may produce a wrong perception of the real status of the stocks and advice, and may lead to a unsustainable utilization of the potential productivity of the resources.

6.7.9 Scientific advice

6.7.9.1 Short term considerations

6.7.9.1.1 State of the spawning stock size

The index of stock abundance from GRUND survey shows high variability throughout the time series, but no trend is observed. The index of abundance from MEDITS surveys, that approximates a spawning stock biomass index (mostly represented by mature fish), suggests an almost steady status from 1994 to 2009 with a high interannual fluctuation. In the absence of a precautionary reference point the STECF EWG- 11-12 is unable to fully evaluate the status of the stock size.

6.7.9.1.2 State of recruitment

Recruitment shows a slight increasing trend, especially in the most recent years.

6.7.9.1.3 State of exploitation

The EWG 11-12 proposes F_{msy} =0.47 as limit management reference point consistent with high long term yield an low risk of fisheries collapses. The stock is considered overexploited (Bcurr/B_{MSY} of about 0.6), with estimates of the current fishing mortality F_{2010} of 0.54 (derived from ASPIC) that is higher to the estimated values that were considered limit reference point obtained with the same approach (F_{MSY}=0.47) and the RP derived from the yield-per-recruit analysis ($F_{0.1}$ =0.48). The current F estimated by Length Cohort Analysis was of 0.59 considering the fully exploited age classes. Yield per recruit analysis suggest that the size of first capture is too low (growth overfishing). An increase in yield is expected in the case a reduction of fishing effort do occur and/or more selective gears are used. EWG reccomends the fleet fishing effort to be reduced until fishing mortality is at or below the estimated F_{msy} level.

6.7.9.2 Medium term considerations

Short and medium term predictions of stock biomass and catches will be accomplished during the follow-up meeting (16-20 January 2012) depending on data availability.

6.8 Stock assessment of striped red mullet in GSA 09

6.8.1 Stock identification and biological features

6.8.1.1 Stock Identification

Striped red mullet (*Mullus surmuletus*) is a demersal species concentrated on the continental shelf. Even though the species can be found at depths over 250 m, it is mainly concentrated in the depth range 0-150 m. Although the species is present on muddy/sandy bottoms, it prefers heterogeneous substrates characterized by alternation of sand, rocks, coralligenous and shells. In the coastal area the species is often associated to *Posidonia oceanica* beds.

Reproduction occurs from May to June and the recruits, finished their pelagic phase at a size of 6,5 cm of total length, massively concentrate near shore. Then, the specimens tend to move to deeper waters increasing the size.

Due to a lack of information about the stock identification of striped mullet population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries. As a matter of fact, there is not any available definition of unit stocks neither based on genetics, bio-chemistry, fishery-based nor on any alternative method based on somatic features. Under a management point of view, in the frame of GFCM, it has been decided, when the lack of any evidence does not allow suggesting an alternative hypothesis, that inside each one of the GSAs boundaries inhabits a single, homogeneous striped red mullet stock that behaves as a single well-mixed and self-perpetuating population.

The hypothesis of a single stock of striped red mullet in GSA9, which includes waters belonging to 2 seas (Ligurian and Tyrrhenian) separated by the Elba Island and fleets that do not show any spatial overlapping is almost unlikely.

6.8.1.2 Growth

The growth of striped red mullet has been studied in the GSA 09 using otolith lectures. The following sets of Von Bertalanffy growth parameters were estimated: Females: $L\infty$ = 32.0, K=0.44, t0=-0.80; Males: $L\infty$ = 28.0, K=0.44, t0=-0.90. The life cycle is of 8-9 years. As for the other species of *Mullus* genus, females of striped red mullet attain larger size than males (40 and 30 cm TL, respectively). The growth rates by age seem to be quite similar between the two sexes.

The diet of striped red mullet shows clear differences according to individual size and season. It is mainly made up of crustaceans, especially decapods and amphipods, but also polichaeta and bivalve molluscs are other frequent preys.

6.8.1.3 Maturity

No information was documented during EWG 11-12 meeting.

6.8.2 Fisheries

6.8.2.1 General description of fisheries

The species is exploited by different types of gears. The annual landing for 2009 was due for 30% to bottom trawl (75 tons), for 31% to Gillnet (76 tons) and for 39% to trammel net (96 tons).
About 200 bottom trawlers exploit this resource all year round in the coastal area, some of them using devices to exploit hard bottoms where the species is more abundant. Striped red mullet is caught as a part of a species mix that constitutes the target of the trawlers operating near shore. The main associated species

caught in GSA9 are *Squilla mantis*, *Sepia officinalis*, *Trigla lucerna*, *Merluccius merluccius*, *Mullus barbatus*, *Z. faber*. The length at first capture of striped red mullet is about 10 cm. Trawl catch is mainly composed by age 0+ individuals while the older age classes are poorly represented in the catch.
As concerns artisanal fisheries, *M. Surmuletus* is caught by gillnet and trammel net. In some period of the year (end of spring-summer), the species represents the target of the artisanal fishery. In particular, part of the fleet uses a small mesh size trammel net to catch it on rocky bottoms near the shore. The catch is mainly composed by age 0+ and 1 individuals.

6.8.2.2 Management regulations applicable in 2010 and 2011

- Minimum landing sizes: EC regulation 1967/2006: 11 cm TL for striped red mullet.
- Fishing closure for trawling: 30-45 days in late summer (not every year have been enforced)
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets have been replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast. However, towed gears are always forbidden inside 1.5 miles from the coast with the exception of some areas of the Ligurian Sea that have benefited from the derogation according by the EC Regulation 1967/2006 for the Mediterranean Sea.
- Two small No Take Zones ("Zone di Tutela Biologica", ZTB) are present inside the GSA 09; one off the Giglio Island (50 km^2, northern Tyrrhenian Sea) another off Gaeta, (125 km^2, central Tyrrhenian Sea). Bottom fishing was not allowed in the two ZTB. A recent regulation of the Italian Ministry of Agricultural, Food and Forestry Policies has established that fishing activity can be carried out in these two areas from July 1st to December 31st.

6.8.2.3 Catches

6.8.2.3.1 Landings

The landing showed a clear decreasing trend in the period 2004-2009 (Fig. 6.8.2.3.1.1 and Tab. 6.8.2.3.1.1), with maximum value in 2005 (404 tons) and minimum in 2008 (224 tons). It is difficult to correlate this decline with the reduction in fishing effort as it is not possible to quantify the real effort exerted by the fleet on this resource. However, the LPUEs calculated on the entire fleet show considerable fluctuations with a decreasing trend, particularly evident for the gillnet (Fig. 6.8.2.3.1.2).

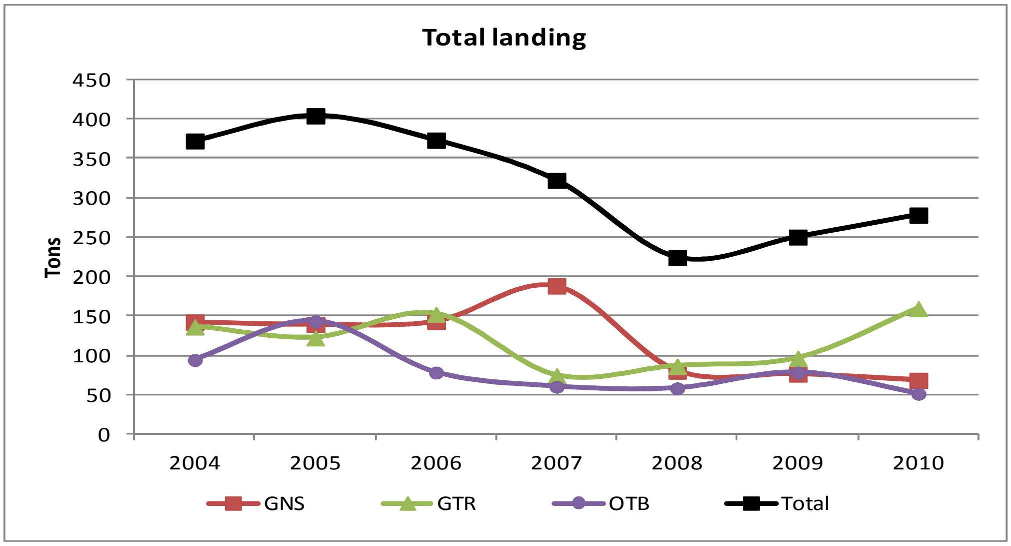


Fig. 6.8.2.3.1.1 Landings (in tons) from the trawl and small-scale fleets in the GSA 09 in the period 2004-2010 (official 2010 DCF data call). GNS: gillnets; GTR: trammel net; OTB: demersal trawling.

Tab. 6.8.2.3.1.1 Landings (in tons) of striped red mullet as reported through the official 2010 DCF data call.

	2004	2005	2006	2007	2008	2009	2010
Otter trawl	94	143	78	60	58	78	51
Gillnet	142	139	143	188	80	76	68
Trammel net	136	122	152	74	86	96	159
Total	372	404	373	322	224	250	278

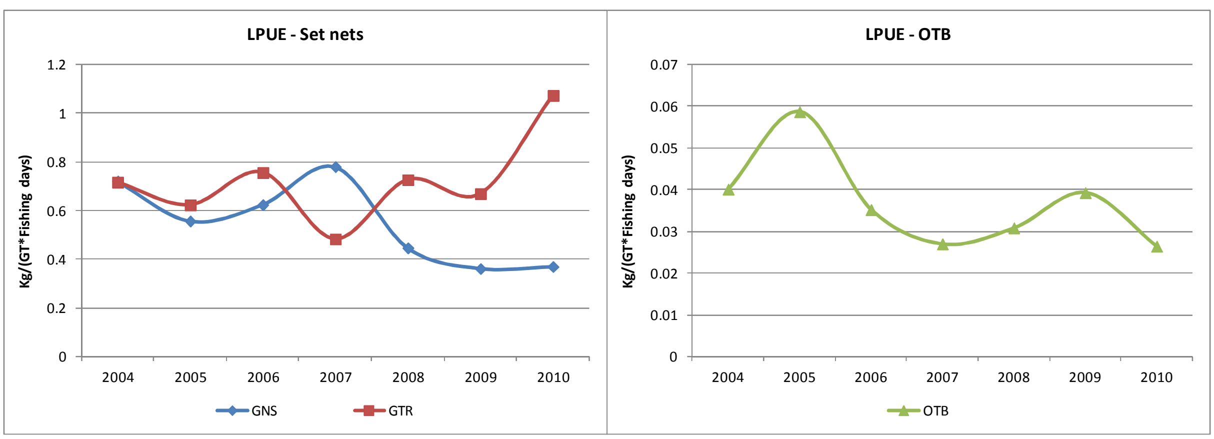


Fig. 6.8.2.3.1.2 Landing per Unit of Effort (LPUE) for set nets (left) and trawling (right) in the GSA 09 for the period 2004-2010 (official 2010 DCF data call). GNS: gillnets; GTR: trammel net; OTB: demersal trawling.

6.8.2.3.2 Discards

According to the data collected in 2009 in the framework of DCF, the discard of striped red mullet from trawling is negligible (0.8 tons). This fraction is composed by specimens under the minimum landing size. No information is available about the discard of set nets for the species.

6.8.2.4 Fishing effort

The fishing capacity of the GSA 09 has shown in these last 10 years a progressive decrease; from 1996 to 2007. Fishing effort (GT*fishing days) performed by the GSA 09 trawlers fishing for demersal species decreased from about 2,342,000 in 2004 to about 1,986,000; a decreasing trend has been detected also for trammel net, from 190,000 in 2004 to 143,000 in 2009, while gillnet showed a slightly increase from 197,000 in 2004 to 210,000 in 2009 (Fig. 6.8.2.4.1).

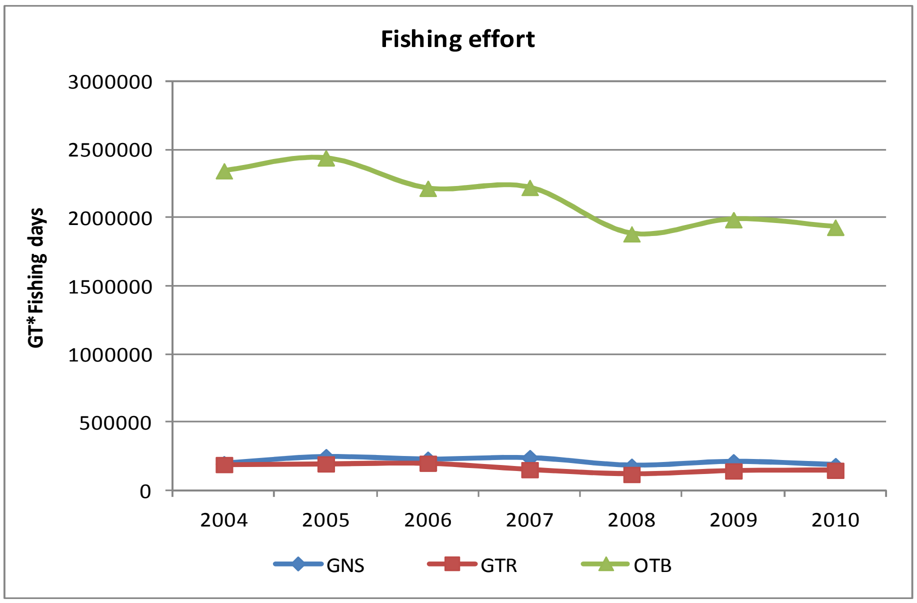


Fig. 6.8.2.4.1 Fishing effort (GT* fishing days) for the different type of gears in the GSA 09 during 2004-2010.

6.8.3 Scientific surveys

6.8.3.1 MEDITS

6.8.3.1.1 Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 01 the following number of hauls was reported per depth stratum (Tab. 6.8.3.1.1.1).

Tab. 6.8.3.1.1.1. Number of hauls per year and depth stratum in GSA09, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA09_010-050	21	20	20	20	21	20	20	19	15	14	15	16	15	15	16	16	15
GSA09_050-100	21	21	20	20	20	21	22	23	17	18	17	16	18	18	16	16	19
GSA09_100-200	38	40	40	40	39	39	38	38	30	30	30	31	29	30	31	31	29
GSA09_200-500	40	40	42	42	41	41	42	41	32	33	36	35	36	37	34	34	35
GSA09_500-800	33	32	31	31	32	32	31	32	26	25	22	22	22	20	23	23	22
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$
$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$
Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.8.3.1.2 Trends in abundance and biomass

Fishery independent information regarding the state of striped red mullet in GSA09 was derived from the international survey MEDITS. Figure 6.8.3.1.2.1 displays the estimated trend in abundance and biomass in depth stratum 0-200 m. The estimated abundance and biomass indices do not reveal a clear trend. However, the recent estimates indicate a low stock size in 2008 and 2009.

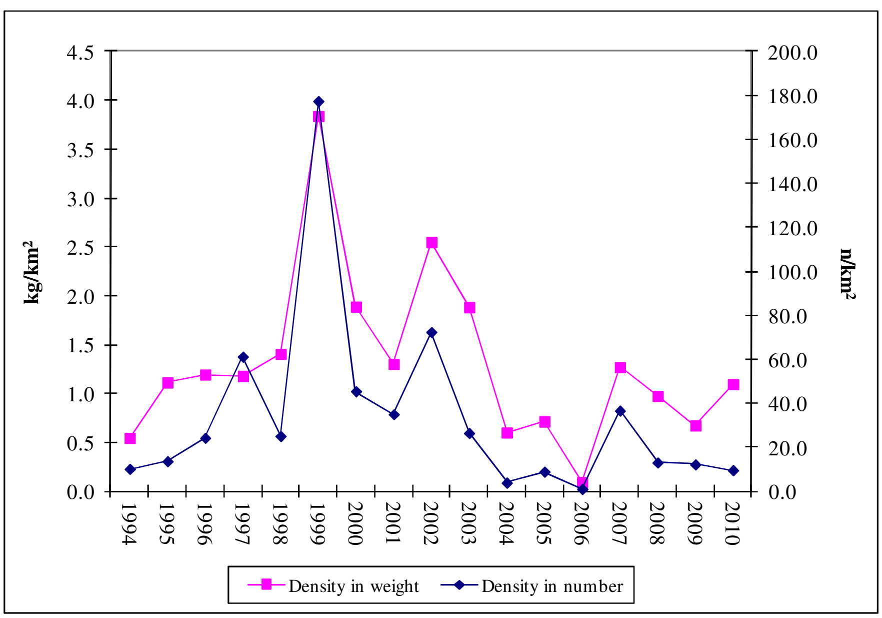


Fig. 6.8.3.1.2.1 Trends of the density indices estimated through the MEDITS survey. Based on the DCR data

call, abundance and biomass indices were recalculated.

6.8.3.1.3 Geographical distribution patterns

No information was documented during EWG 11-12 meeting.

6.8.3.1.4 Trends in abundance by length or age

No information was been documented.

6.8.3.1.5 Trends in growth

No information was been documented.

6.8.3.1.6 Trends in maturity

No information was been documented.

6.8.4 Assessments of historic stock parameters

6.8.4.1 Method 1: Length Cohort Analysis

6.8.4.1.1 Justification

This is the first assessment of striped red mullet in the GSA 09. A LCA was performed aimed at the estimation of a vector of F at size, using data on total annual catches by size, including discard for trawling. Considering that only data for 2009 were available, it was not possible to perform a formal VPA. The software used to carry out the analyses was VIT.

6.8.4.1.2 Input parameters

Catch of red striped mullet are from three fisheries: bottom trawlers targeting a coastal demersal assemblage and artisanal fisheries using trammel nets and gillnets.

The length frequency distribution and the age frequency distribution of the three gears landing for sexes combined are shown in Fig. 6.8.4.1.2.1 and in Fig. 6.8.4.1.2.2, respectively.

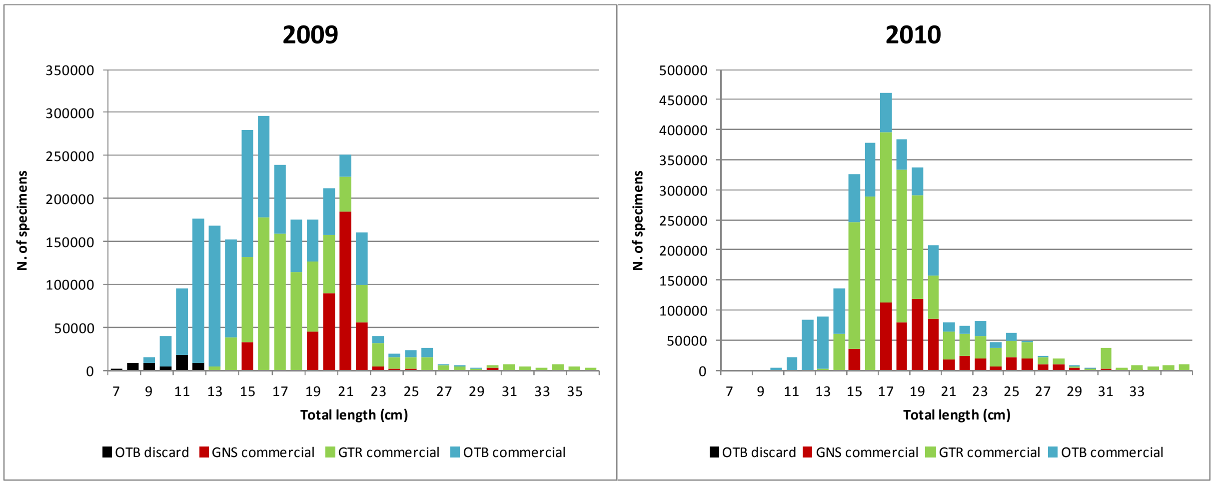


Fig. 6.8.4.1.2.1 Size frequency distributions of trawl fleet (OTB), gillnet (GNS) and trammel net (GTR) for 2009 and 2010.

The exploited size range is wide, from 8 to 33 cm TL, corresponding to specimens between 0+ and 7 age classes. The trawl landing is mainly composed by specimens of size comprised between 11 and 22 cm TL, most of which belonging to 0+ and 1 age classes; discard from trawling is quite negligible and composed by specimens under the minimum legal size. Gillnet landing shows a narrow size range (19-22 cm TL) corresponding to age 1 individuals. Trammel net landing is characterised by a wide size range, although the majority of the specimens are comprised between 14 and 23 cm TL (0+ and 1 age classes).

Tab. 6.8.4.1.2.1 reports the number of specimens by age class and "metier" landed in the GSA 09 during 2009.

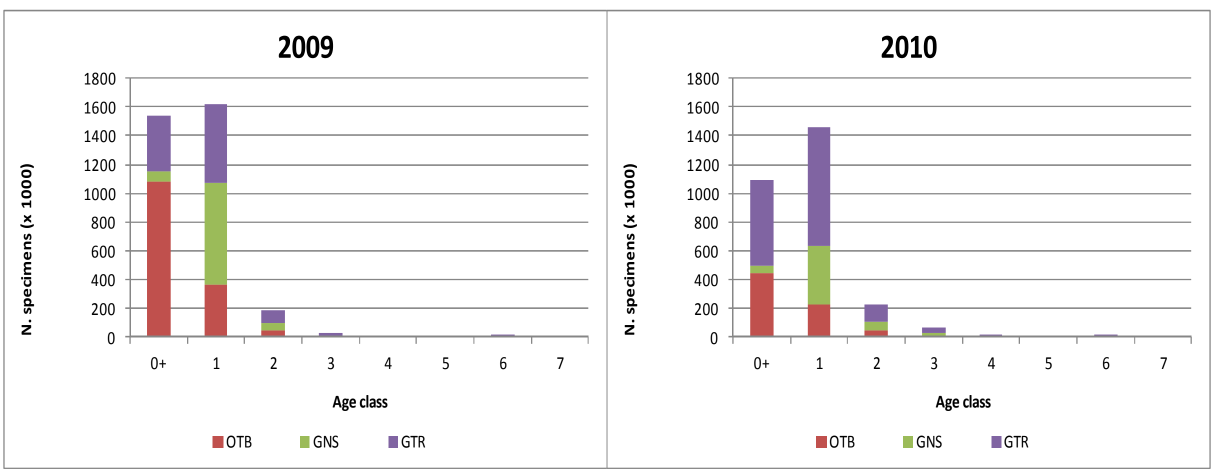


Fig. 6.8.4.1.2.2 Landings numbers at age for the two years.

Tab. 6.8.4.1.2.1 Landing numbers at age (in thousands), 2009 (left) and 2010 (right).

Class	Total catch	OTB	GNS	GTR
0+	1537	1084	65	388
1	1617	370	704	543
2	188	51	51	86
3	34	11	0	23
4	6	1	1	4
5	12	0	5	8
6	21	0	0	21
7	7	0	0	7
Total	3422	1517	825	1080

Class	Total catch	OTB	GNS	GTR
0+	1089	448	47	594
1	1456	233	403	820
2	226	54	60	112
3	69	2	30	37
4	13	1	7	5
5	8	0	1	6
6	24	0	1	22
7	7	0	0	7
Total	0	0	0	0

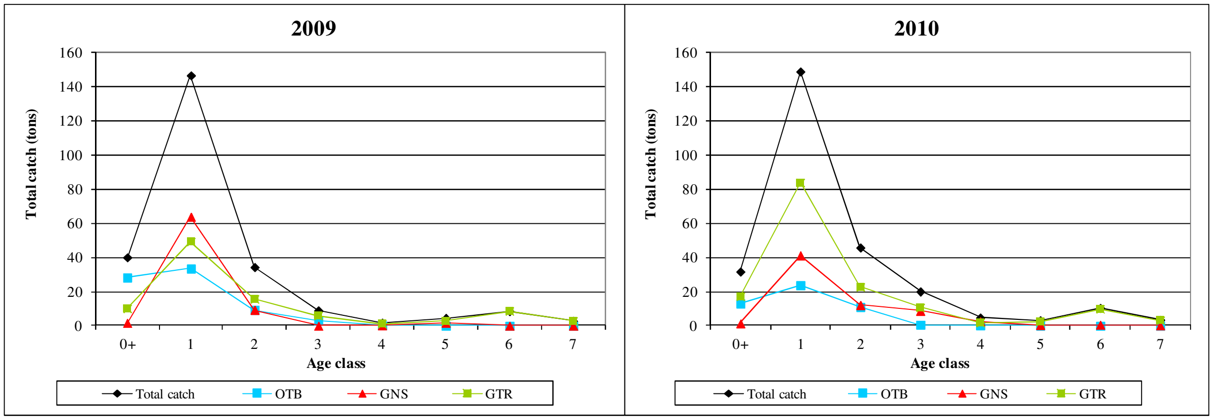
The following set of parameters was used to perform the LCA:

Growth parameters (Von Bertalanffy)
$L\infty$ = 32.0 (cm, total length, TL)
K = 0.43
to = -0.70
L*W
a = 0.01
b = 3.103
Natural mortality
M vector Age_1=0.49, Age_2=0.26, Age_3=0.22, Age_4=0.20, Age_5=0.19, Age_6=0.18, Age_7=0.18, Age_8=0.17
Length at maturity (L_{50})
L_{50} = 11.5 cm TL
Proportion of matures
Age_1=0.65, Age_2=1.00, Age_3=1.00, Age_4=1.00, Age_5=1.00, Age_6=1.00, Age_7=1.00, Age_8=1.00

The vector of natural mortality M was estimated using the software Prodbiom.

6.8.4.1.3 Results

VIT results regarding the pattern of catch reconstruction by age, year and “metier”, and the total and fishing mortality by age and “métier”, are showed in Fig. 6.8.4.1.3.1. The total catch in biomass is mainly based on the fish of age class 1, particularly abundant in the catches of trammel net and gillnet. Age class 0+ is important in the catches of trawling. Ages older than 2 are instead the major target of trammel net. Fishing mortality peaked for specimens of age classes 1 and 2.



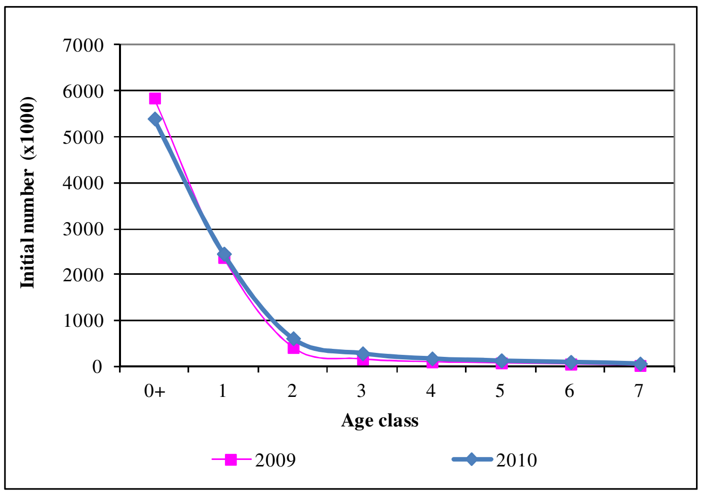


Fig. 6.8.4.1.3.1 LCA outputs: catch in biomass and initial number at age of *M. surmuletus* in the GSA 09.

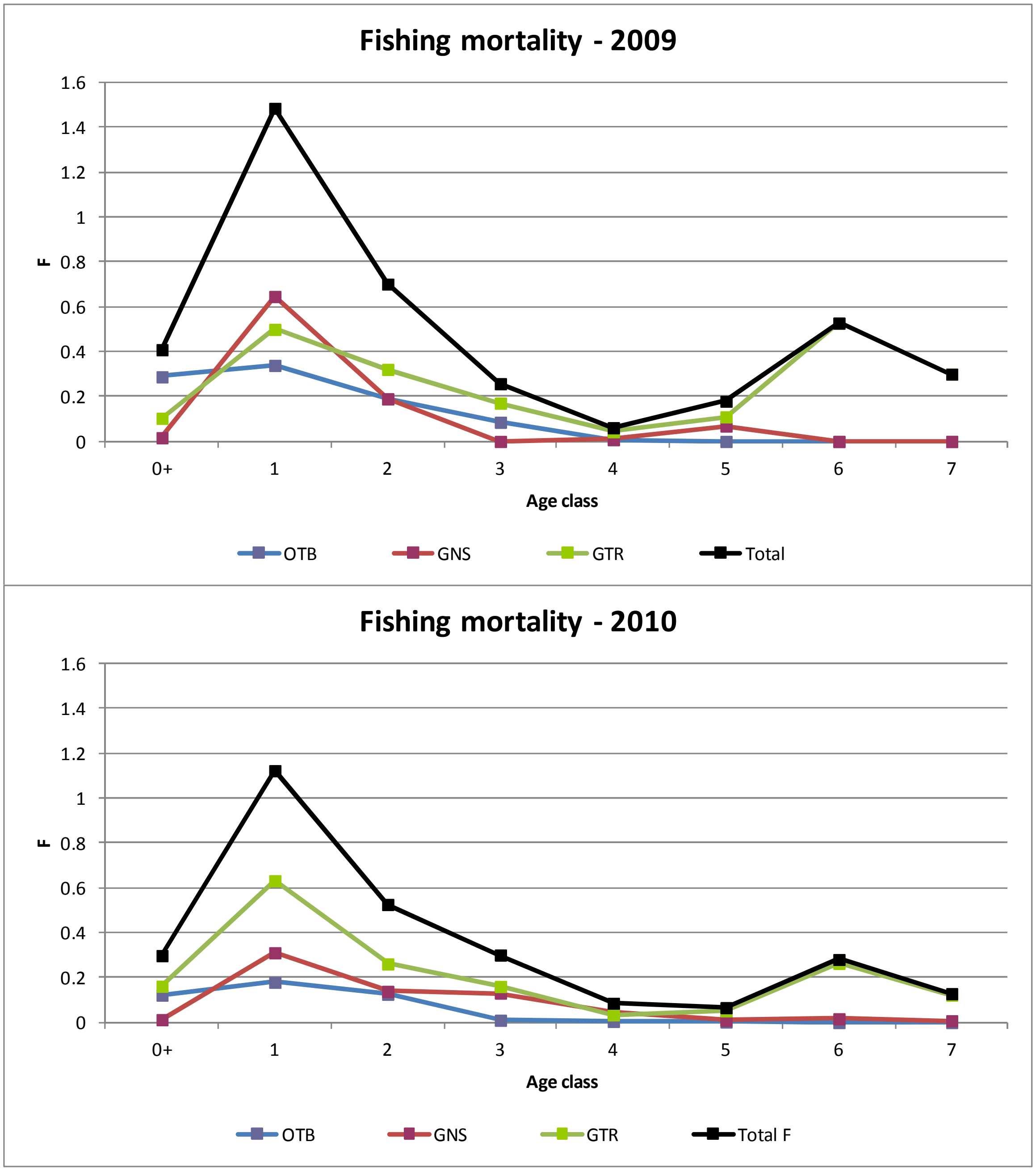


Fig. 6.8.4.1.3.1 LCA outputs: catch in biomass and initial number at age of *M. surmuletus* in the GSA 09.

6.8.5 Long term prediction

6.8.5.1 Justification

Yield per recruit analysis was conducted based on the exploitation pattern resulting from the VIT model and population parameters.
The Y/R analysis allowed to estimate the relative yields and surviving fraction of the parental biomass and to produce an estimate of $F_{0.1}$ which can be considered a proxy of F_{MSY}.

The Yield per Recruit (YPR) routine, included in the stock assessment toolbox of NOAA was used. It is based on the Thompson-Bell model for estimating the expected lifetime yield and biomass from a cohort subjected to varying levels of fishing mortality. The present version incorporates estimates of life-history parameters such as mean age, mean generation time, reproductive value, expected number of spawning specimens, reproductive output from first-, second- and multiple time spawners.

6.8.5.2 Input parameters

Input parameters are given under the section of the historic parameter assessment by means of VIT.

6.8.5.3 Results

Tab. 6.8.5.3.1 shows the reference fishing mortality (Fref), along with the reference points $F_{0.1}$ and the F_{max}. The value of F current was obtained averaging the estimated F values of age classes 0+, 1, 2 and 3. Fig. 6.7.5.3.1 shows the results of the yield per recruit analysis and the Y/R and SSB/R.

Tab. 6.8.5.3.1 Reference fishing mortality (F_{refe}) and the referent points $F_{0.1}$ and the F_{max}.

		Factor	Absolute F	Y/R	B/R	SSB
2009	Virgin	0.0	0.0	0.00	577.4	569.9
	$F_{0.1}$	0.4	0.3	45.4	190.3	183.5
	F Current	1.0	0.7	43.4	62.7	56.8
	F_{max}	0.6	0.4	46.9	129.2	122.7
2010	Virgin	0.0	0.0	0.0	635.3	630.2
	$F_{0.1}$	0.6	0.3	49.4	200.5	195.9
	F Current	1.0	0.6	50.7	105.4	101.1
	F_{max}	0.8	0.5	51.2	134.4	130.0
	Mean	$F_{0.1}$	0.3			
		F Current	0.6			
		F_{max}	0.5			

Fig. 6.8.5.3.1 shows the reference fishing mortality (Fref), along with the reference points $F_{0.1}$ and the F_{max}. The value of F current was obtained averaging the estimated F values of age classes 0+, 1, 2 and 3. Fig. 6.8.5.3.2 shows the results of the yield per recruit analysis and the Y/R and SSB/R.

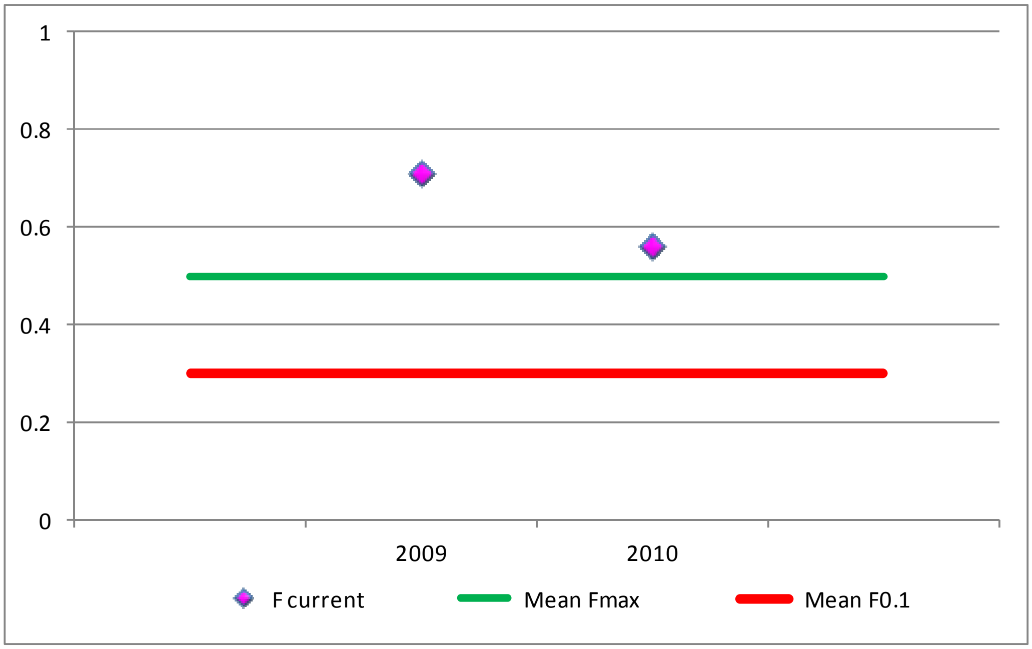


Fig.. 6.8.5.3.1 Reference fishing mortality (F_{refe}) and the referent points $F_{0.1}$ and the F_{max}.

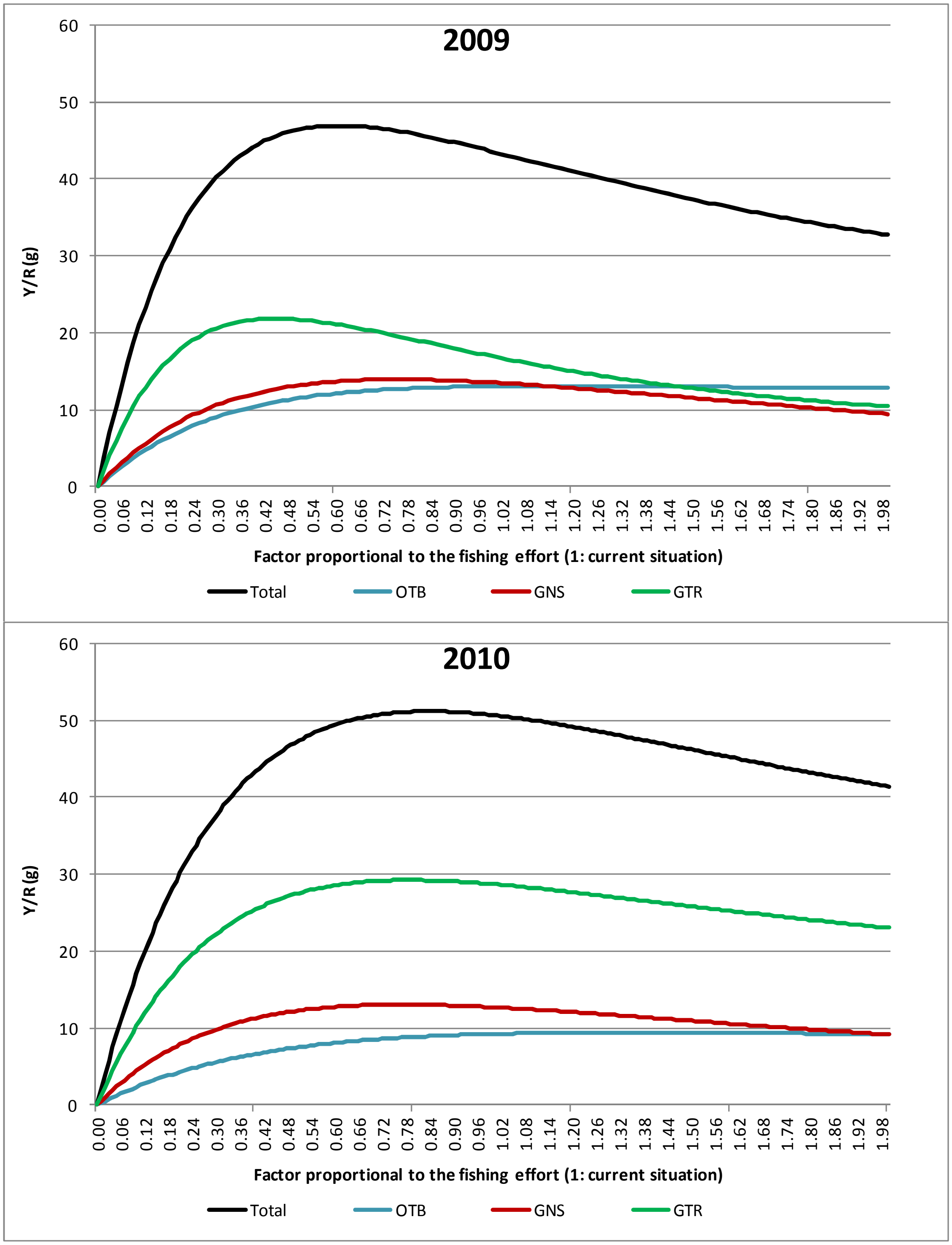


Fig. 6.8.5.3.2 Results of the yield per recruit analysis showing the Y/R and SSB/R.

6.8.6 Data quality

No comment is provided.

6.8.7 Scientific advice

6.8.7.1 Short term considerations

6.8.7.1.1 State of the stock size

EWG 11-12 is unable to fully evaluate the status of the stock size as no precautionary reference point is defined. The analyses performed give a SSB estimation of 335 tons in 2009. The Medits survey indicate recent fluctuations without a clear trend in stock abundance. However, the recent estimates indicate a low stock size in 2008 and 2009.

6.8.7.1.2 State of recruitment

Given the quality of data and results, EWG 11-12 cannot conclude on the state of recruitment. The analyses performed give an estimation of 5.8×10^6 recruits in 2009.

6.8.7.1.3 State of exploitation

EWG 11-12 proposes $F_{0.1} \leq 0.31$ as limit management reference point consistent with high long term yields (F_{MSY} proxy) and low risk of fisheries collapses.

The current F=0.60 in 2010 is above the Y/R $F_{0.1}$ reference point (0.31), which indicates that the stock of striped red mullet in GSA 09 is subject to overfishing.

EWG 11-12 recommends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings. This can be achived by reducing fishing effort of the relevant fleets and acting on selectivity as striped red mullet in GSA 09 is caught in large quantities by set nets targeting the species. Catch forecasts consistent with the adopted measures shall be estimated.

As striped red mullet is mainly caught by different gears and in mixed fisheries, the measures adopted to reduce fishing mortality require multi-annual management plans.

On the other hand, this is the first attempt to evaluate the exploitation state of the species and, therefore, it is necessary to analyze a longer data series in order to confirm the results obtained for 2010.

6.9 Stock assessment of the blue and red shrimp in GSA 09

6.9.1 Stock identification and biological features

6.9.1.1 Stock Identification

Due to a lack of enough information about the structure of blue and red shrimp in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries.

In the GSA09 the blue and red shrimp, *Aristeus antennatus* (Risso, 1816) represent one of the most valuable demersal resources for the trawling fleet operating on the muddy bottoms of the upper and middle slope from 400 to 800 m, where the stock is composed mainly of aggregations of large female spawners (Orsi Relini and Relini, 1979).

The highest abundances have been found in the northern part of the GSA (Ligurian Sea).

The first year of life is scarcely known especially the planktonic phases because the records of larvae are extremely scarce (Heldt, 1955, Seridj, 1971). The smallest individuals collected during the Medits surveys are considered young of the year – 1 year old, because reproduction occurs in a period of six months, from May to October: they are present in low numbers on the Ligurian fishing grounds, but are sometimes very abundant in South Sardinia. In spite of all that, in the past (summer 1987), not only the Gulf of Genoa but the entire Ligurian Riviera up to the borderline with France (red shrimps fishing grounds of the Roja canyon) saw the sudden appearance of a large quantity of small shrimps. These were called “the 1987 recruits” or “ 1987 cohorts”: *de facto* during summer 1987 commercial fishery showed an aggregation of female spawners covering the size range 20-68mm carapace length (CL), with a very new dominant size at about 38mm CL (Orsi Relini *et al*, submitted). Furthermore analysis of MEDITS length frequency distributions and length at age of the commercial landings showed that between 2008 and 2009 another recruitment event took place in the area.

6.9.1.2 Growth

The growth of *A. antennatus* has been studied both in the southern part than in the northern part of the GSA09 using model progression analysis (Colloca *et al*., 1998, Orsi Relini and Relini, 1998). Data on recruitment from the Ligurian Sea (Orsi Relini and Relini, 1998) and results of tagging studies (Relini M. *et al*., 2000, 2004) provided the basis for an interpretation of growth in which the possible life span of *A. antennatus* was of 8-10 years. The following sets of Von Bertalanffy growth parameters were estimated: Females: L_∞ = 76.99, K=0.21, t0=-0.019 (Orsi Relini and Relini, 1998). More recently this interpretation of growth has been confirmed (Orsi Relini *et al*, submitted, Orsi Relini and Mannini, in press).

A. antennatus, as observed by Brian (1931) and Lagardere (1972), has euryphagous feeding behaviour. Its diet includes both organisms captured on the seabed, such as polychaetes, echinoderms, the decapod *Calocaris macandreae,* small bivalves, gasteropods and crustaceans belonging to various groups, as well as eurybate organisms of the micro-nekton, particularly euphasiaceans and decapods (Relini and Orsi Relini, 1987). If the total number of prey is considered, 50% of the diet of *A. antennatus* appears to be composed of crustaceans (Cartes and Sardà, 1989). However, if one considers not only the number but also the size of prey, pelagic decapods such as the *Sergestidae, Pasiphaeidae* and *Oplophoridae* would assume a role of primary importance (Orsi Relini *et al.*, 1995).

6.9.1.3 Maturity

The reproduction period, although with some differences between the various geographic areas of the Mediterranean, is somewhat extended, starting in spring (April), peaking in summer (July-August), when most of the females reach sexual maturity, and ending in autumn (October-November) (Orsi Relini and Relini, 1979; Orsi Relini and Pestarino, 1981; Colloca *et al.*, 1998).

Four stages of maturing of the ovaries were described by using a macroscopic colorimetric scale (Orsi Relini and Relini, 1979; Orsi Relini and Pestarino, 1981). The immature females or those in the post-emission phase have colourless or white ovaries (stage 1). As the stages of vitellogenesis progress and the carotenoproteins are included, the ovaries are first pink-coloured (stage 2) and then lilac coloured (stage 3, the advanced maturity phase, with oocytes of up to 250 μ). At maximum maturity development the gonad takes on a dark purple colour (stage 4, diameter of the oocytes around 300 μ).

In males the reproduction phase appears longer, and mature males were in fact observed with the hemispermatophores in the end portion of the sperm ducts in autumn and winter (Orsi Relini and Pestarino, 1981).

In the Ligurian Sea, the smallest observed mature female measured 31 mm in carapace length (CL) and the smallest mature male 20 mm (CL) (Orsi Relini and Relini, 1979).

In the Northern and Central Tyrrhenian, the smallest observed mature females measured, respectively, 32 mm and 24 mm. (Righini and Abella, 1994; Colloca *et al.*, 1998).

It is well known that fecundity is a power function of length, in fact the ovary forms a volume in the female body. In large crustacean decapods such as lobsters the reproductive potential of the stock largely depends on the biggest females. In the Penaeidea high fecundities are enhanced by the production of pelagic eggs. Details of fecundity in *A. antennatus* in the present area are available (Orsi Relini and Semeria, 1983) and are summarized in the relationship:

Number of eggs = $0.0046\ CL^{2.904}$

6.9.2 Fisheries

6.9.2.1 General description of fisheries

In the GSA 09 the blue and red shrimp is one of the most important target species of the fishery carried out on the muddy bottoms of the upper and middle slope. The species is exclusively exploited with otter bottom trawling.

The main fishing grounds are located in the northern part of the GSA09 (northern Ligurian Sea); they are mainly exploited by several trawlers of Sanremo and Santa Margherita Ligure which operate daily fishing trips.

Generally S. Margherita Ligure’s trawlers leave the port between 3 and 5 a.m. and come back late in the afternoon, while during the main fishing season, in summer, come back between 9 and 10.30 p.m. The customary fishing grounds are situated between Genoa and the bathyal grounds off the Santa Lucia Bank and the Gorgona Isle, representing the largest fishing area of the Ligurian trawlers fleets (Fig. 6.9.2.1.1). The trawlers are moored at buoys closed to the port mole. The catches of each boat are landed by their own tenders in the S. Erasmo wharf. A consistent part of landings is sold in the local market, directly by the fishermen; the most valuable qualities are picked up by a local wholesolder, while the massive product is taken to the Genoa’s market.

The usual fishing grounds of Sanremo’s trawlers are situated between the France border, at west, and the S. Lorenzo Point, at east (Fig. 6.5.2.1.1). Most of the boats fishing on the bathyal canyons of Ventimiglia, San Remo and San Lorenzo, leave the harbour between the 3 and 4 a.m. and come back between 6 and 8 p.m. Landings are taken up and sold by whole solder.

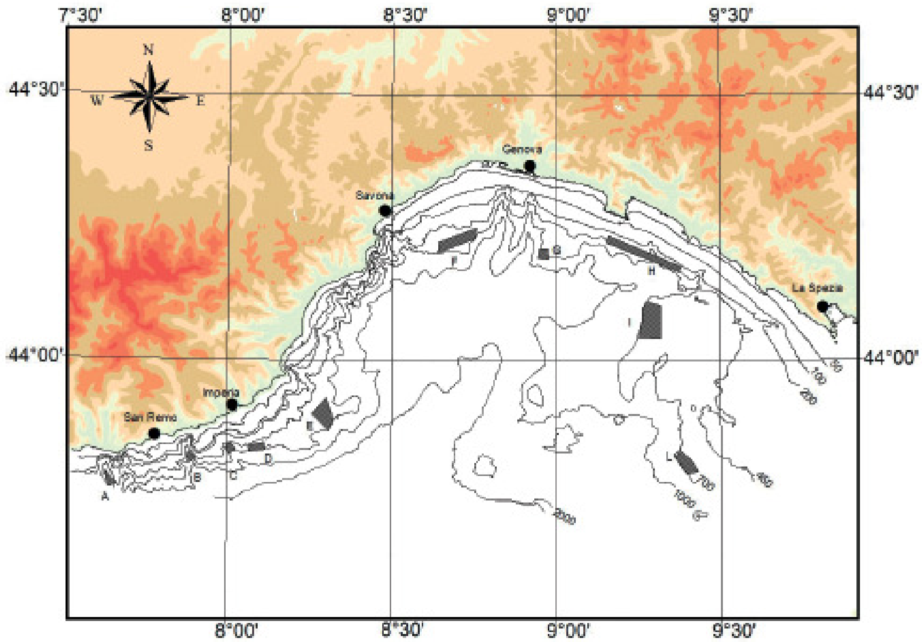


Fig. 6.9.2.1.1 Main fishing areas of *A. antennatus.* A: Ventimiglia Canyon; B: Sanremo Canyon; C: San Lorenzo Canyon; D: Vapore Bank; E: Capo Mele Bank; F: Arenzano Bank; G: Banchetto Bank; Di terra le rame Canyon; I: Di fuori le rame Bank; L: S. Lucia Bank (Fiorentino et al., 1998).

The Figure 6.9.2.1.2 shows LPUE (from March 2009 to May 2010) of Sanremo and S. Margherita Ligure which represent the two main fleet exploiting blue and red shrimps in the GSA 09 (Mannini, 2010).

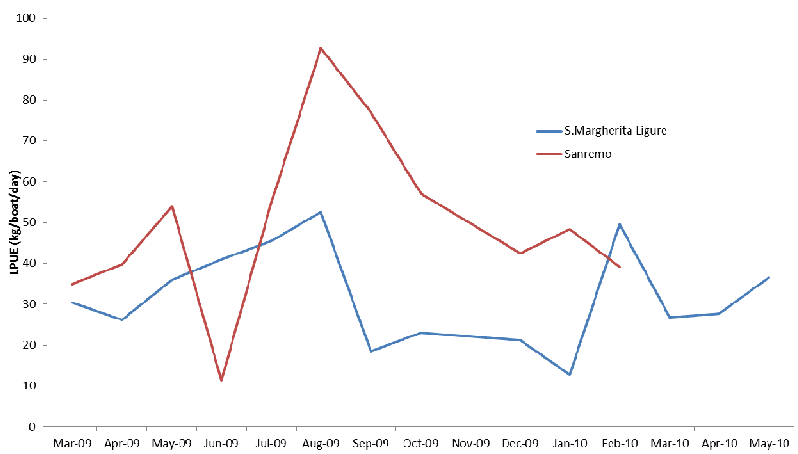


Fig.6.9.2.1.2 *A. antennatus* LPUE of Santa Margherita Ligure and Sanremo from March 2009 to May 2010.

The age structure of the landings, according to the DCR data, shows that the catch ranged between the age classes 2+ and 7+ (Fig.6.9.2.1.3); in the 2008 is noticeable the presence of juveniles.

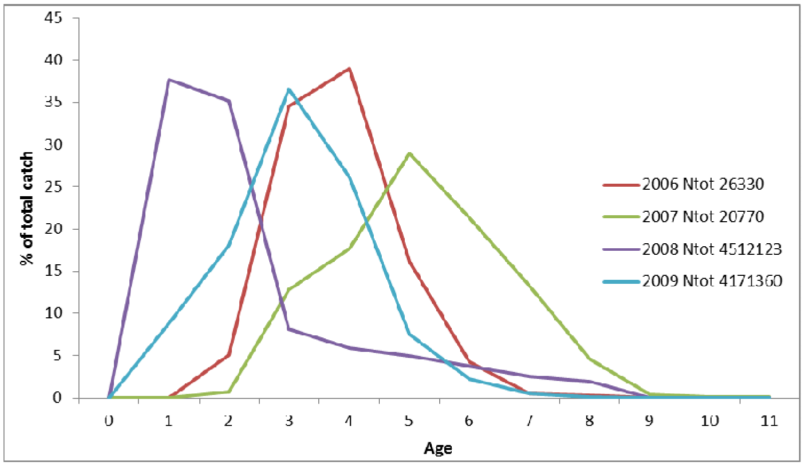


Fig.6.9.2.1.3 Age frequency distribution of *A. antennatus* landed in the GSA 09 from 2006 to 2009.

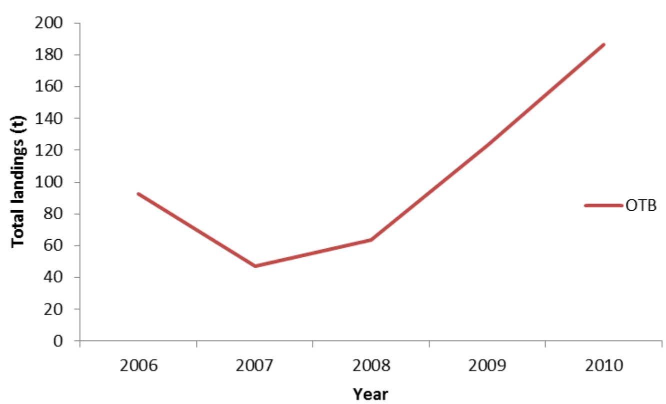
6.9.2.2 Management regulations applicable in 2010 and 2011

EC regulation 1967/2006 do not provide for a minimum length size for this species. Italian national law provided in the last years a fishing ban of a month which, for the Ligurian fleet, is enforced after the summer fishing season.

6.9.2.3 Catches

6.9.2.3.1 Landings

Total landings of blue and red shrimps decreased from about 90 tons in 2006 to 47 tons in 2007 than a remarkable increasing phase took place up to about 186 tons in 2010 (Fig. 6.9.2.3.1.1; Tab. 6.9.2.3.1.1). The landings are entirely taken by OTB fleets. Seasonality fluctuations are a proper characteristic of the landings of this species, as shown by the LPUE produced by the fleet of Santa Margherita Ligure in the period 1987-1996 (Fig. 6.9.2.3.1.2).



6.9.2.3.1.1 Total landings by gear in GSA 09.

Tab. 6.9.2.3.1.1 Annual landings (t) by fishing technique in GSA 09 as provided through the official DCF data call 2011.

COUNTRY	YEAR	GEAR	AREA	SPECIES	OTB
ITA	2006	OTB	SA 9	ARA	92.70
ITA	2007	OTB	SA 9	ARA	47.37
ITA	2008	OTB	SA 9	ARA	63.46
ITA	2009	OTB	SA 9	ARA	123.50
ITA	2010	OTB	SA 9	ARA	186.40

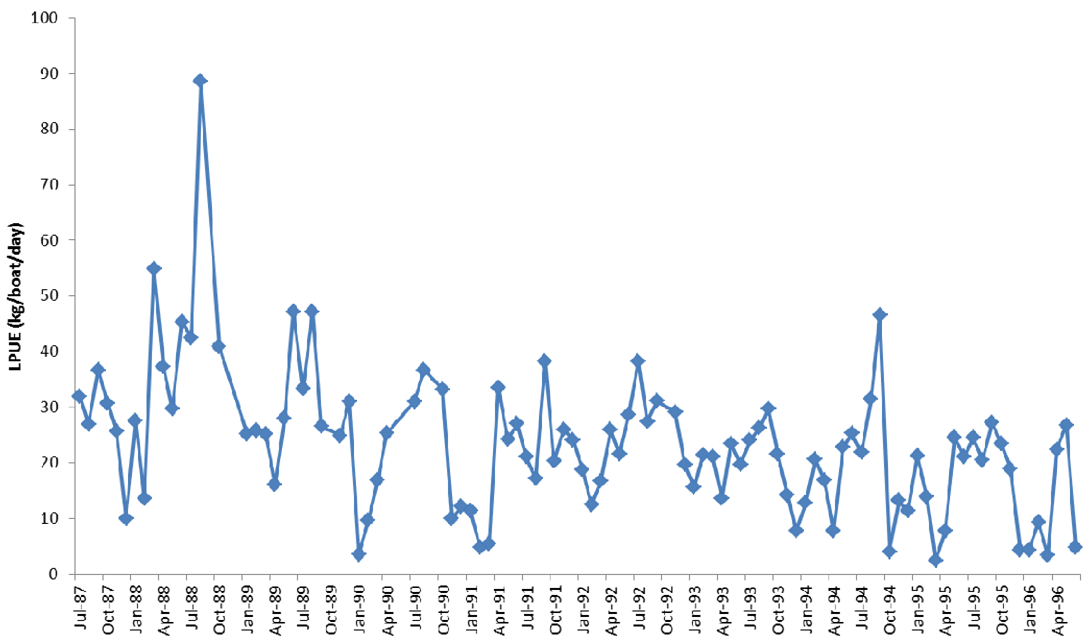


Fig. 6.9.2.3.1.2 Time series of LPUE of Santa Margherita Ligure from July 1987 to October 1996.

6.9.2.3.2 Discards

Discarding of *A. antennatus* was not observed.

6.9.2.3.3 Fishing effort

The trends in fishing effort by fishing technique are listed in Tab. 6.9.2.3.3.1. From 2005 to 2008 the effort decreased, while in the last three years a slightly increase was detected (Figure 6.9.2.3.3.1).

Tab. 6.9.2.3.3.1Trends in annual fishing effort as nominal effort (kW*days) and GT*days at sea deployed in GSA09 from 2004 to 2010.

COUNTRY	AREA	YEAR	GEAR	NOMINAL EFFORT	GT DAYS AT SEA
ITA	SA9	2004	OTB	8321497	1440765
ITA	SA9	2005	OTB	12710127	2160331
ITA	SA9	2006	OTB	9432075	1746412
ITA	SA9	2007	OTB	8404088	1433624
ITA	SA9	2008	OTB	2792267	545085
ITA	SA9	2009	OTB	2571948	446688
ITA	SA9	2010	OTB	3603156	668052

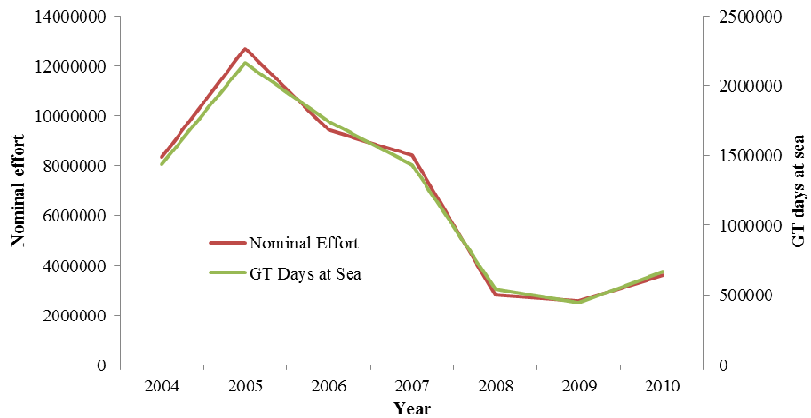


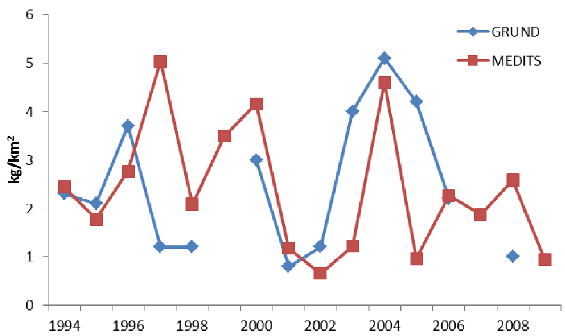
Fig. 6.9.2.3.3.1 Trends in annual fishing effort as nominal effort (kw*days) and GT*days at sea deployed in GSA 09 from 2004 to 2010.

6.9.3 Scientific surveys

6.9.3.1 MEDITS

6.9.3.1.1 Methods

Since 1994 two trawl surveys are regularly carried out each year: MEDITS, in spring, and GRUND, in autumn. The two surveys gave a similar temporal trend in density and biomass of blue and red shrimp and large fluctuations are present from year to year (Fig. 6.9.3.1.1.1).



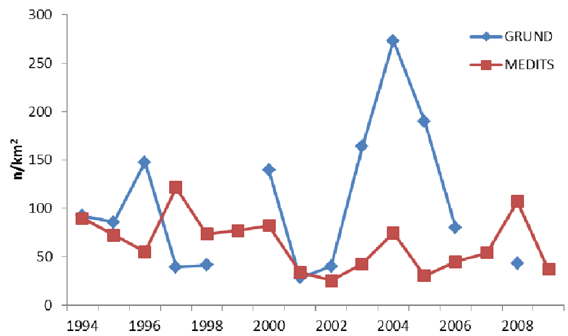


Fig. 6.9.3.1.1.1 *A. antennatus*: GRUND and MEDITS trends in density and biomass from 1994 to 2009 in GSA 09.

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls was reported per depth stratum (Tab. 6.9.3.1.1.1).

Tab. 6.9.3.1.1.1. Number of hauls per year and depth stratum in GSA09, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA09_010-050	*21*	*20*	*20*	*20*	*21*	*20*	*20*	*19*	*15*	*14*	*15*	*16*	*15*	*15*	*16*	*16*	*15*
GSA09_050-100	*21*	*21*	*20*	*20*	*20*	*21*	*22*	*23*	*17*	*18*	*17*	*16*	*18*	*18*	*16*	*16*	*19*
GSA09_100-200	*38*	*40*	*40*	*40*	*39*	*39*	*38*	*38*	*30*	*30*	*30*	*31*	*29*	*30*	*31*	*31*	*29*
GSA09_200-500	*40*	*40*	*42*	*42*	*41*	*41*	*42*	*41*	*32*	*33*	*36*	*35*	*36*	*37*	*34*	*34*	*35*
GSA09_500-800	*33*	*32*	*31*	*31*	*32*	*32*	*31*	*32*	*26*	*25*	*22*	*22*	*22*	*20*	*23*	*23*	*22*
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120

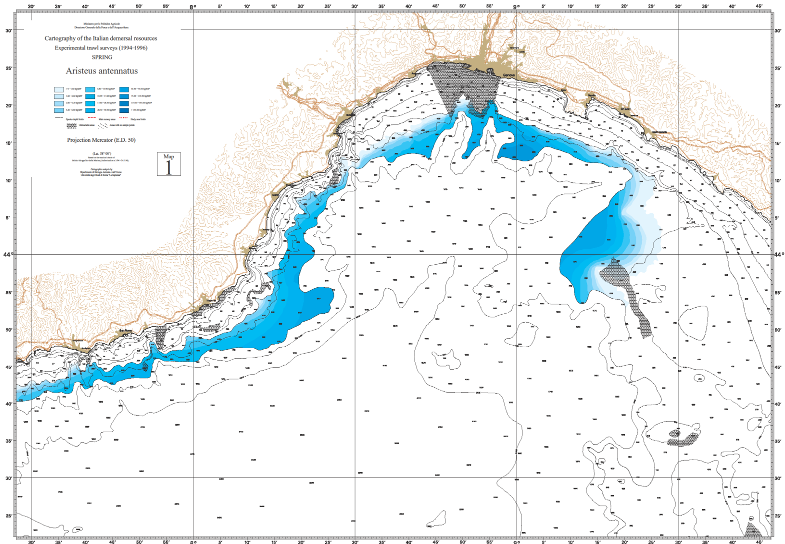
Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$
$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$
Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.9.3.1.2 Geographical distribution patterns

The stock is more abundant in the northern part of the GSA (Ligurian Sea) as showed in Figure 6.9.3.1.2.1 (from Ardizzone *et al*., Eds. CD-ROM Version)


Cartography of the Italian demersal resources
Experimental trawl surveys (1994-1996)
SPRING
Aristeus antennatus
Projection Mercator (E.D. 50)
Map
1

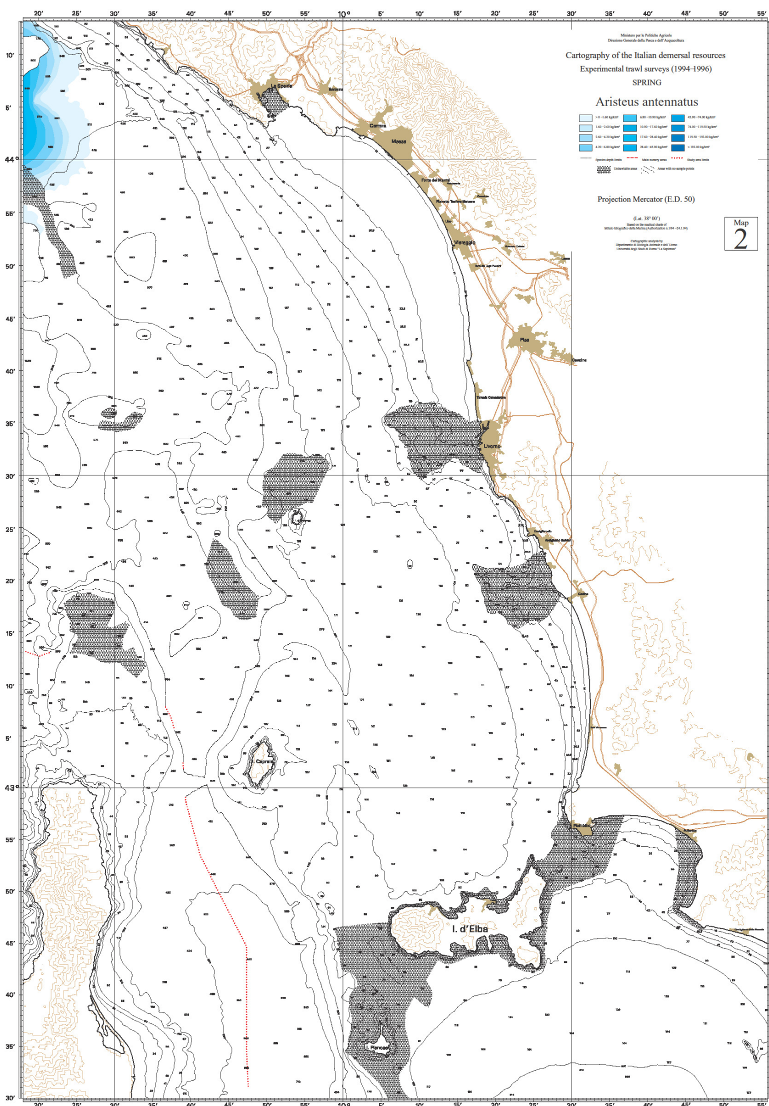
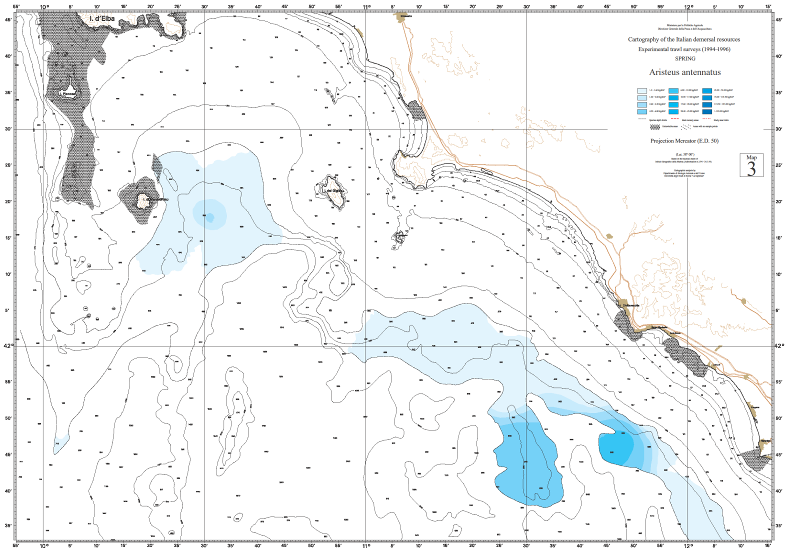

Ministero per le Politiche Agricole
Direzione Generale della Pesca e dell'Acquacoltura
Cartography of the Italian demersal resources
Experimental trawl surveys (1994–1996)
SPRING
Aristeus antennatus
> 0 –1.60 kg/km²
1.60 –2.60 kg/km²
2.60 –4.20 kg/km²
4.20 –6.80 kg/km²
6.80 –10.90 kg/km²
10.90 –17.60 kg/km²
17.60 –28.40 kg/km²
28.40 –45.90 kg/km²
45.90 –74.00 kg/km²
74.00 –119.50 kg/km²
119.50 –193.00 kg/km²
> 193.00 kg/km²
Species depth limits
Main nursery areas
Study area limits
Untrawlable areas
Areas with no sample points
Projection Mercator (E.D. 50)
(Lat. 38° 00')
Based on the nautical charts of
Istituto Idrografico della Marina (Authorization n.1/94 –24.1.94)
Cartographic analysis by
Dipartimento di Biologia Animale e dell'Uomo
Università degli Studi di Roma "La Sapienza"
Map
2
La Spezia
Carrara
Massa
Viareggio
Pisa
Livorno
Capraia
I. d'Elba

Fig. 6.9.3.1.2.1 *A. antennatus*: Adult specimens biomass 1994-1996, GSA09 (Ligurian Sea).



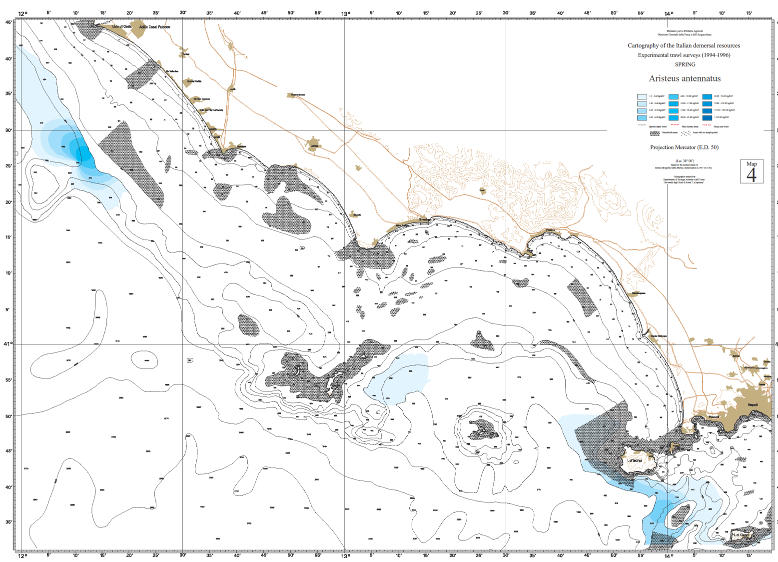


Fig. 1.9.3.1.2.2 *A. antennatus*: Adult specimens biomass 1994-1996, GSA 09 (Northern and central Tyrrhenian Sea).

6.9.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the blue and red shrimp in GSA 09 was derived from the international survey MEDITS. Figure 6.9.3.1.3.1 displays the estimated trend in *A. antennatus* abundance and biomass in GSA 09. The estimated abundance and biomass indices do not reveal a clear trend. In the period analyzed (2006-2010) indices showed a quite stationary phase followed by a remarkable increase in 2010 both in terms of biomass and abundance indices.

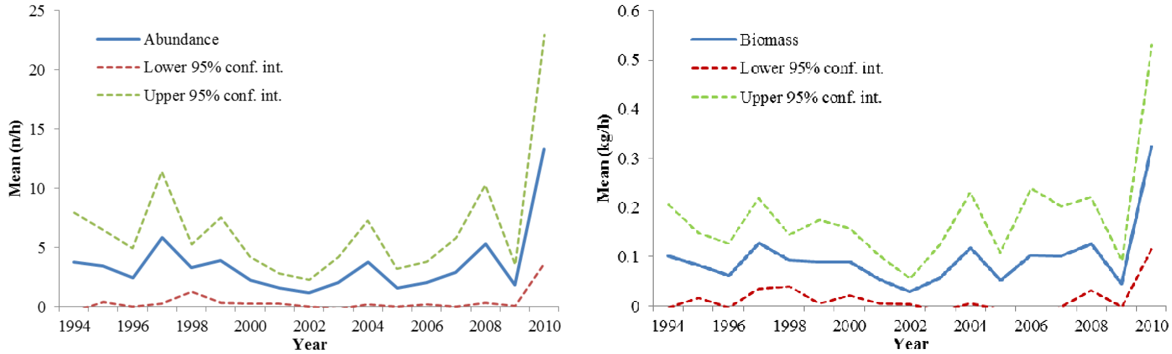


Fig. 6.9.3.1.3.1 Abundance and biomass indices of blue and red shrimp in GSA 09.

6.9.3.1.4 Trends in abundance by length or age

The following Fig. 6.9.3.1.4.1-3 display the stratified abundance indices of GSA 09 in 1994-2010.

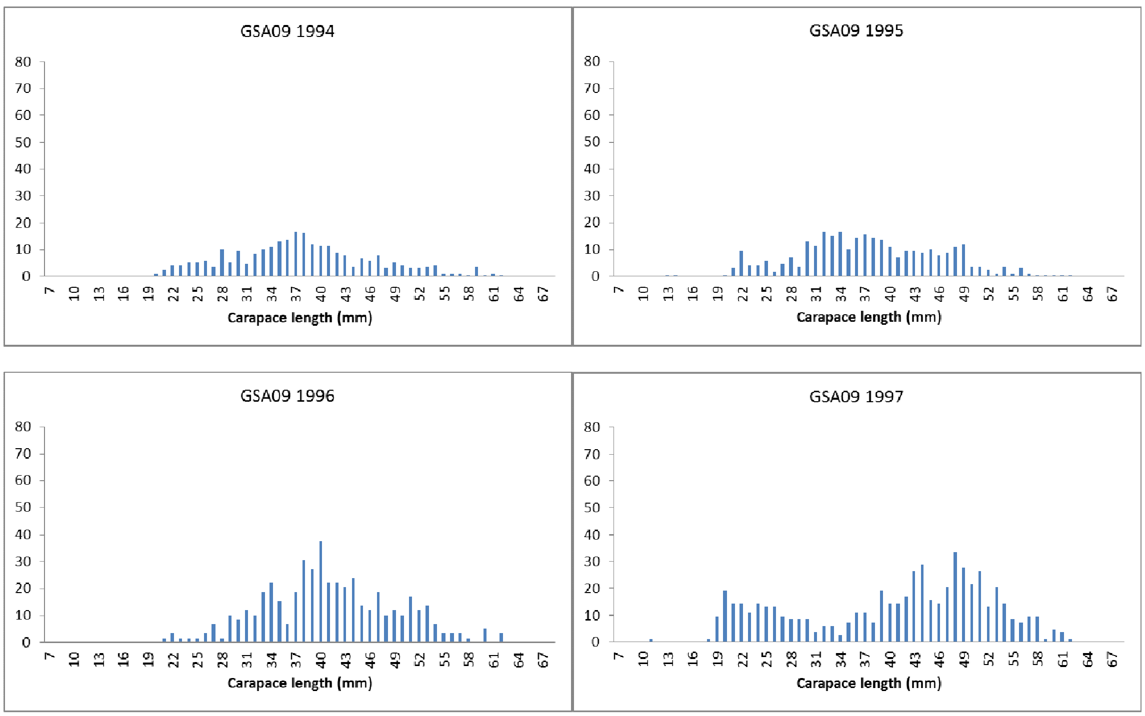


Fig. 6.9.3.1.4.1 Stratified abundance indices by size, 1994-1997.

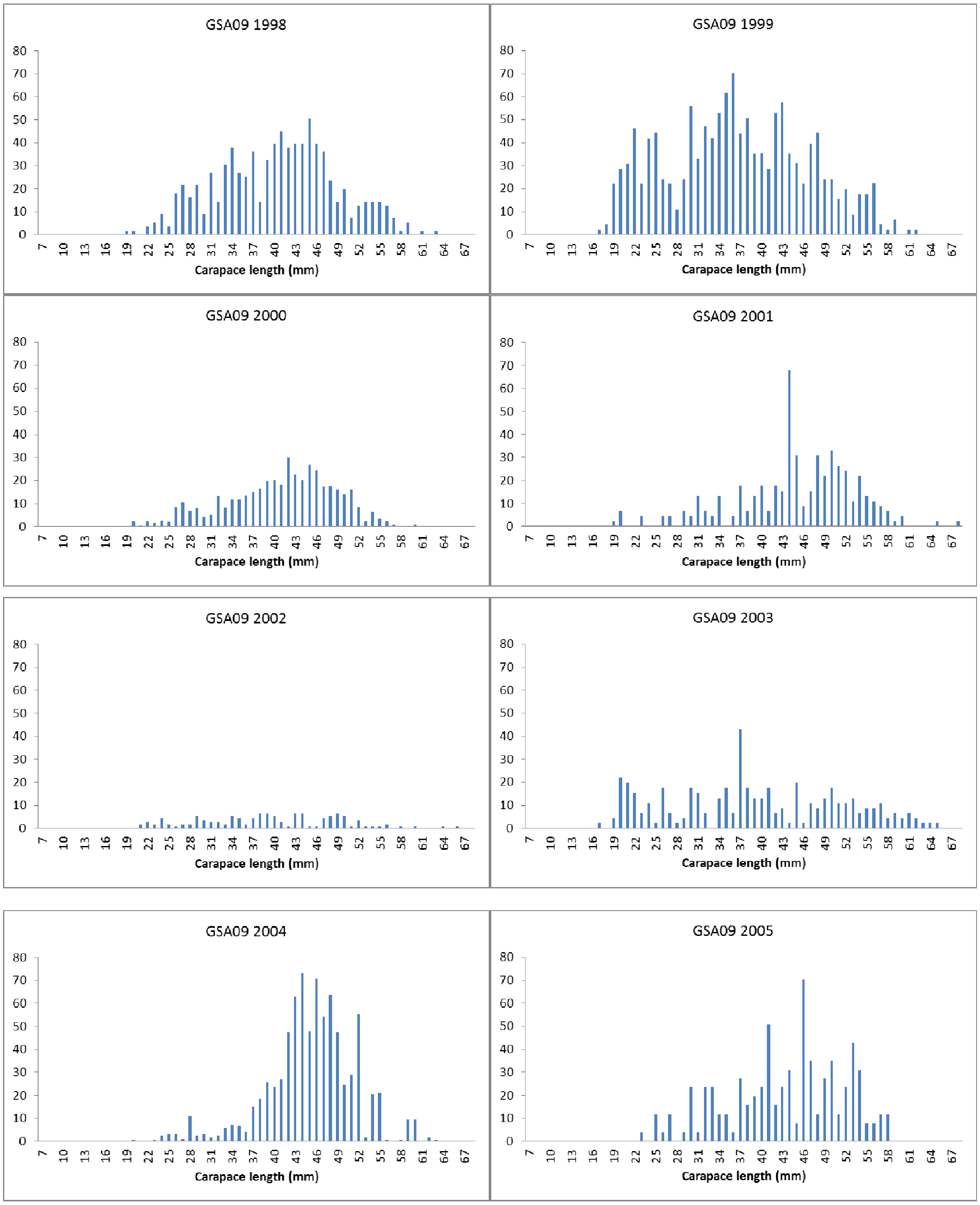


Fig. 6.9.3.1.4.2 Stratified abundance indices by size, 1998-2005.

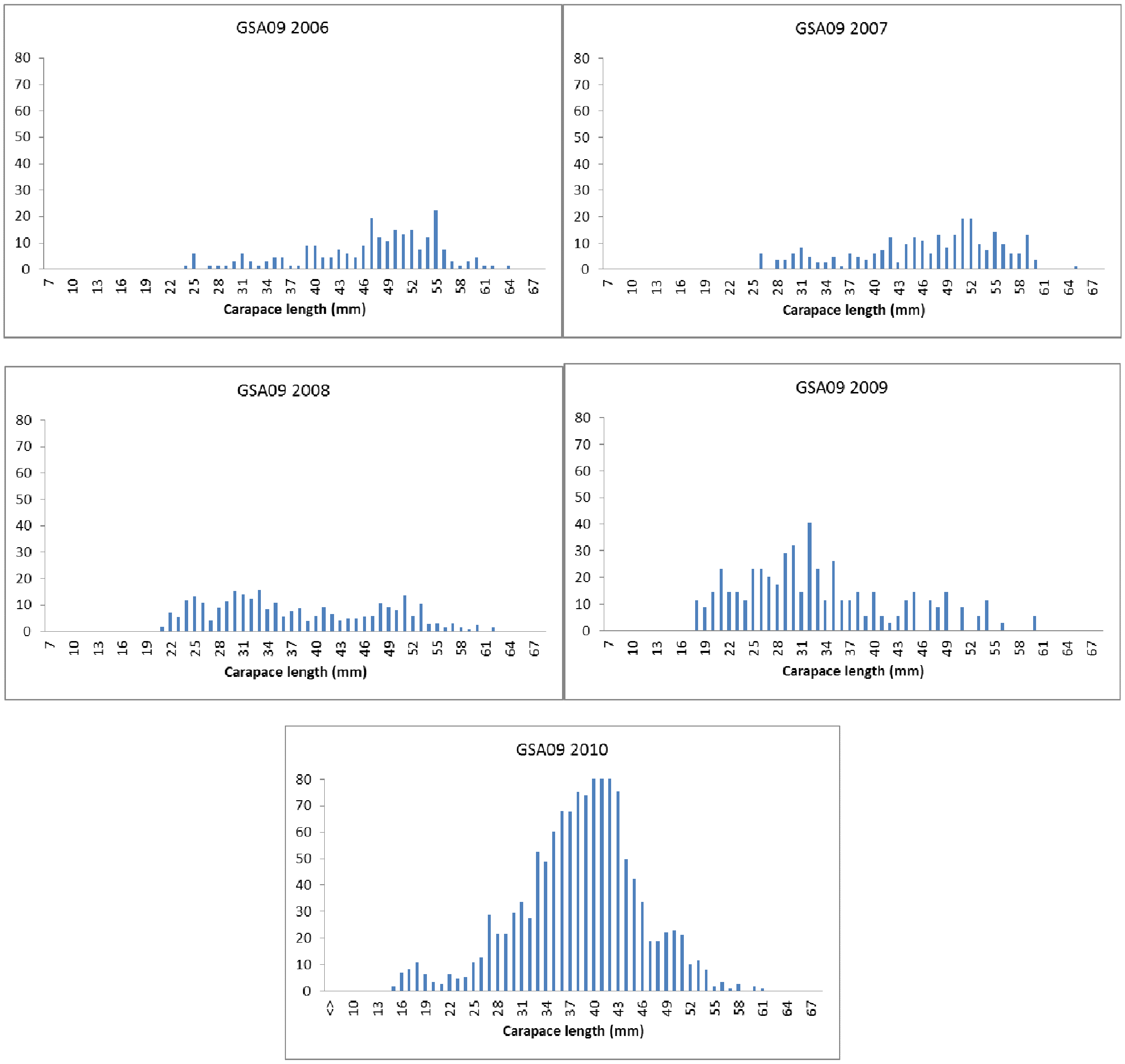


Fig. 6.9.3.1.4.3 Stratified abundance indices by size, 2006-2010.

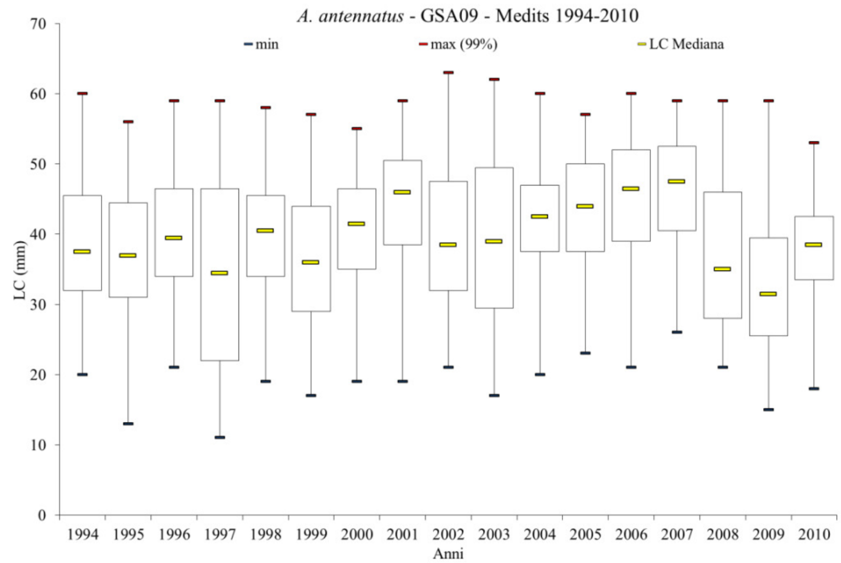


Fig. 6.9.3.1.4.4 Boxplot of the length frequency distributions obtained in the Medits surveys.

6.9.3.1.5 Trends in growth

No analyses were conducted during EWG 11-12 meeting.

6.9.3.1.6 Trends in maturity

No analyses were conducted during EWG 11-12 meeting.

6.9.4 Assessment of historic stock parameters

6.9.4.1 Method 1: LCA

6.9.4.1.1 Justification

The pseudo-cohort analysis VIT was applied using data from 2006 to 2010.

6.9.4.1.2 Input parameters

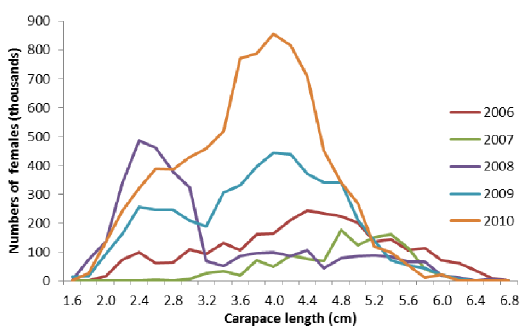
Data from DCF provided at EWG 11-12 contained information on blue and red shrimp landings and the respective size structure for 2006-2010. A VPA was performed using a Length Cohort Analysis (LCA) and applying the routine included in the VIT package designed by Lleonart and Salat (1992) for each year separately. Biological parameters are listed in Tab. 6.9.4.1.2.1 and data used are reported in Tab. 6.9.4.2.1.2. A natural mortality vector computed by ProdBiom was used. Total length frequency was splitted by sex using a sex-ratio vector per length class (Fig. 6.9.4.2.1.1).

Tab. 6.9.4.2.1.1. Input data for LCA of blue and red shrimp in GSA 09.

	Growth	**Length-Weight relationships**	**Natural mortality**	**Proportion of matures**
Female	L∞ =7.69 cm CL K = 0.21 t0 = -0.019	a = 0.0029 b = 2.429	Mvector = 0.75 (age 1), 0.49 (age 2), 0.40 (age 3), 0.36 (age 4),0.33 (age 5),0.32 (age 6), 0.30 (age 7), 0.29 (age 8), 0.29 (age 9), 0.28 (age 10)	age(0)=0.4 age(1)=0.8 age(2)=1 age(3)=1 age(4)=1 age(5)=1 age(6)=1 age(7)=1 age(8)=1 age(9)=1 age(10)=1
Male	L∞ = 4.6 cm CL K = 0.213 t0 = -0.019	a = 0.005 b = 2.286	Mvector = 0.76 (age 1), 0.50 (age 2), 0.41 (age 3), 0.36 (age 4),0.34 (age 5),0.32 (age 6), 0.31 (age 7), 0.30 (age 8), 0.29 (age 9), 0.28 (age 10)	age(0)=0.4 age(1)=0.8 age(2)=1 age(3)=1 age(4)=1 age(5)=1 age(6)=1 age(7)=1 age(8)=1 age(9)=1 age(10)=1

Tab. 6.5.4.2.1.2. Input data for LCA Catch at length 2006-2010.

Carapace Length (cm)	2006	2007	2008	2009	2010
1.6	0	0	0	15576	1769
1.8	0	0	115768	23837	39381
2.0	27960	0	231538	159299	232489
2.2	109361	0	501666	241734	359576
2.4	143269	0	713910	376784	472073
2.6	89508	5714	676974	360126	568506
2.8	83124	0	501666	326459	510874
3.0	121952	5714	367313	235884	488085
3.2	96537	27925	71986	194713	477937
3.4	130922	32662	51237	310026	523806
3.6	105589	18377	85395	332997	773782
3.8	159557	69544	94952	394630	788296
4.0	161888	48095	98077	443962	855315
4.2	209704	87216	86685	439080	814620
4.4	243044	76221	105418	370450	706967
4.6	232834	67173	42425	341305	449616
4.8	222169	176144	78237	340458	340090
5.0	199426	122690	85396	210509	268221
5.2	136315	150144	88703	138560	118985
5.4	143841	159333	83924	70881	97977
5.6	106247	114161	64828	53756	52479
5.8	111806	41797	66663	41902	9361
6.0	70799	18170	17078	20376	21030
6.2	60106	2504	10283	6726	0
6.4	35547	0	0	273	0
6.6	7425	0	5141	273	0
6.8	1280	0	0	0	0



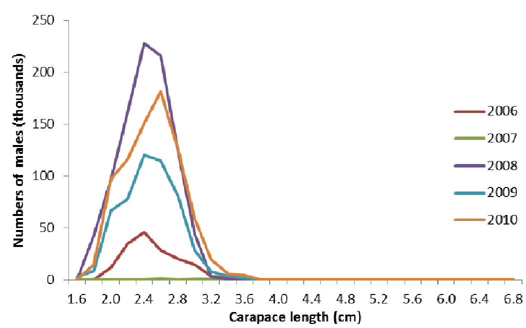


Fig. 6.9.4.2.1.1. Input data for LCA Catch at length by sex 2006-2010

6.9.4.1.3 Results

Blue and red shrimp landings are concentrated on adults of age classes 2 onward. High landings were observed in 2008 and 2009. In 2009 and in particular in 2008 high catches of juveniles was observed. Fishing mortality impact specimens of age classes 2-3 onward (Fig. 6.9.4.1.3.1). Even though analysis was performed for each year, the EWG 11-05 agreed to the opportunity to consider only the results coming from the first two years in order to be more consistent with the steady state assumption of LCA method (Jones, 1981). In Fig. 6.9.4.1.3.2 biomass per recruit and yield per recruit curves of *A. antennatus* females in the GSA09 are shown.

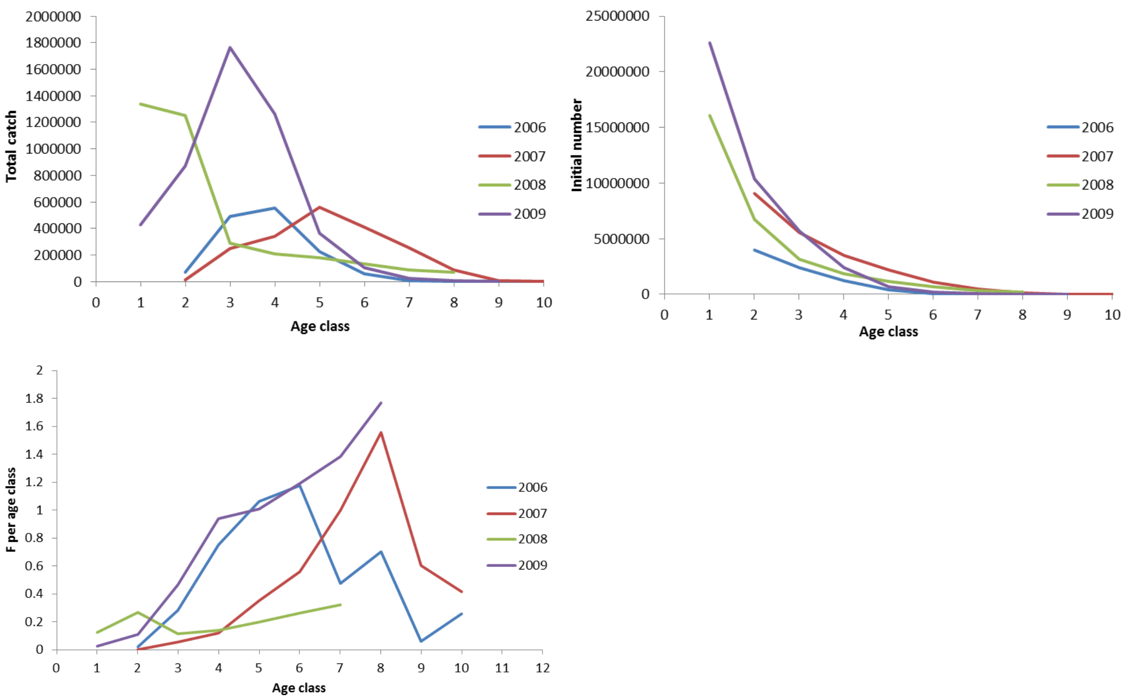


Fig.6.9.4.1.3.1 LCA outputs: catch numbers, numbers-at-age and fishing mortality at age of *A. antennatus* in the GSA09.

6.9.5 Long term prediction

6.9.5.1 Justification

The yield per recruit from the VIT was applied.

6.9.5.2 Input parameters

The length frequency data from 2006 and 2010 and the biological parameters were used as given in table 6.9.5.2.1.

Tab. 6.9.5.2.1. Input data for Y/R of blue and red shrimp in GSA 09.

	Growth	**Length-Weight relationships**	**Natural mortality**
Female	L∞ =7.69 cm CL K = 0.21 t0 = -0.019	a = 0.0029 b = 2.449	Mvector = 0.75 (age 1), 0.49 (age 2), 0.40 (age 3), 0.36 (age 4),0.33 (age 5),0.32 (age 6), 0.30 (age 7), 0.29 (age 8), 0.29 (age 9), 0.28 (age 10)
Male	L∞ = 4.6 cm CL K = 0.213 t0 = -0.019	a = 0.005 b = 2.286	Mvector = 0.76 (age 1), 0.50 (age 2), 0.41 (age 3), 0.36 (age 4),0.34 (age 5),0.32 (age 6), 0.31 (age 7), 0.30 (age 8), 0.29 (age 9), 0.28 (age 10)

	FEMALE					MALE				
Carapace Length (cm)	2006	2007	2008	2009	2010	2006	2007	2008	2009	2010
1.6	0	0	0	12466	1416	0	0	0	3110	353
1.8	0	0	73347	15102	24951	0	0	42421	8735	14430
2.0	16269	0	134723	92690	135276	11691	0	96815	66609	97213
2.2	74147	0	340130	163896	243793	35214	0	161536	77838	115783
2.4	97510	0	485895	256443	321298	45759	0	228015	120341	150775
2.6	60918	3889	460740	245097	386918	28590	1825	216234	115029	181588
2.8	62646	0	378080	246036	385020	20478	0	123586	80423	125854
3.0	107121	5019	322643	207197	428727	14831	695	44670	28687	59358
3.2	92632	26795	69074	186837	458604	3905	1130	2912	7876	19333
3.4	129413	32286	50646	306452	517768	1509	376	591	3574	6038
3.6	105032	18280	84944	331239	769698	557	97	451	1758	4084
3.8	159557	69544	94952	394630	788296	0	0	0	0	0
4.0	161888	48095	98077	443962	855315	0	0	0	0	0
4.2	209704	87216	86685	439080	814620	0	0	0	0	0
4.4	243044	76221	105418	370450	706967	0	0	0	0	0
4.6	232834	67173	42425	341305	449616	0	0	0	0	0
4.8	222169	176144	78237	340458	340090	0	0	0	0	0
5.0	199426	122690	85396	210509	268221	0	0	0	0	0
5.2	136315	150144	88703	138560	118985	0	0	0	0	0
5.4	143841	159333	83924	70881	97977	0	0	0	0	0
5.6	106247	114161	64828	53756	52479	0	0	0	0	0
5.8	111806	41797	66663	41902	9361	0	0	0	0	0
6.0	70799	18170	17078	20376	21030	0	0	0	0	0
6.2	60106	2504	10283	6726	0	0	0	0	0	0
6.4	35547	0	0	273	0	0	0	0	0	0
6.6	7425	0	5141	273	0	0	0	0	0	0
6.8	1280	0	0	0	0	0	0	0	0	0

6.9.5.3 Results

The resulting Y/R and SSB/R are illustrated in the following figures. All ages reference point $F_{0.1}$=0.32 while in table 6.9.5.3.1 are reported the main result of the LCA analysis.

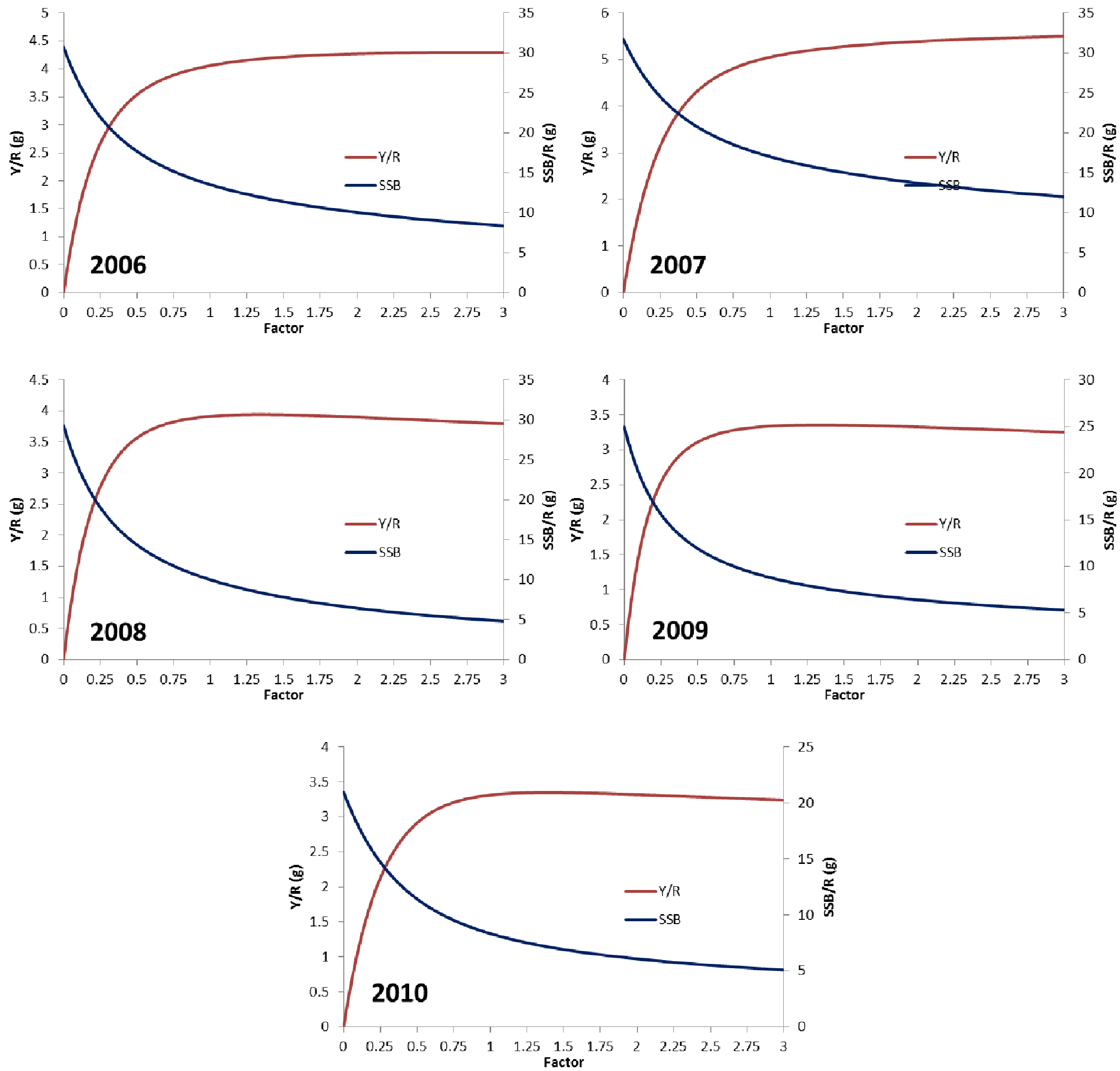


Fig. 6.9.5.3.1 LCA outputs: Yield per recruit per recruit and Spawning stock Biomass per recruits curves of *A. antennatus* females in the GSA09.

Table 6.9.5.3.1 LCA outputs.

		Factor	Absolute F	Y/R	B/R	SSB
2006	Virgin	0.00	0.00	0.00	41.03	40.42
	$F_{0.1}$	0.58	**0.32**	4.15	24.19	23.59
	F_c	1.01	0.57	4.65	19.84	19.24
	F_{max}	2.88	1.62	5.02	12.67	12.08
2007	Virgin	0.00	0.00	0.00	34.93	34.31
	$F_{0.1}$	0.56	**0.34**	4.43	23.17	22.56
	F_c	1.01	0.62	4.91	20.08	19.47
	F_{max}	3.00	1.84	5.23	15.03	14.41
2008	Virgin	0.00	0.00	0.00	36.94	36.40
	$F_{0.1}$	0.52	**0.28**	3.98	18.47	17.96
	F_c	1.01	0.54	4.36	13.03	12.53
	F_{max}	1.47	0.79	4.39	11.27	10.78
2009	Virgin	0.00	0.00	0.00	37.07	36.48
	$F_{0.1}$	0.37	**0.30**	4.14	20.17	19.58
	F_c	1.01	0.82	4.72	12.97	12.40
	F_{max}	1.31	1.06	4.74	11.75	11.17
2010	Virgin	0.00	0.00	0.00	29.80	29.21
	$F_{0.1}$	0.60	**0.34**	4.33	15.10	14.52
	F_c	1.01	0.57	4.67	11.94	11.36
	F_{max}	1.41	0.80	4.71	10.45	9.88
	Mean	***$F_{0.1}$***	***0.32***			
		F_c	***0.62***			
		F_{max}	***1.22***			

6.9.6 Data quality

Medits survey data were available from 1994 to 2010 and since high differences in abundance and biomass per hour indexes was recognized between EWG 11-05 and EWG 11-12 a check needs to be done. Least differences was also recognized in the length frequency landings.

6.9.7 Scientific advice

6.9.7.1 Short term considertations

6.9.7.1.1 State of the stock size

Stock assessment has been computed by Length Cohort Analysis (VIT software) using DCF data of landings at age (2006-2010). Results obtained did not show a clear trend in the stock size. Medits survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. In the period analyzed (2006-2010) indices of biomass and abundance showed a stationary phase followed by a remarkable increase in 2010. Since no precautionary level for the stock of blue and red shrimp in GSA 09 was proposed, STECF

EWG 11-12 cannot evaluate the stock status in relation to the precautionary approach.

6.9.7.1.2 State of recruitment

Box-plot of Medits length frequency distributions have shown that in the 2008-2009 a remarkable recruitment phase seems to took place in the area. The high recruitment event of 2008 is confirmed also in the length at age distribution of the commercial landings.

6.9.7.1.3 State of exploitation

EWG 11-12 proposes $F_{0.1} \leq 0.32$ as limit management reference point consistent with high long term yields (F_{MSY} proxy).

According to the F estimates obtained using Length Cohort Analysis, average F all ages (0.62) was over the estimated average $F_{0.1}$ values. In this case, the stock would not appear to be able to sustain the current level of fishing effort in the GSA09 and thus EWG 11-12 considers the stock to be subject to overfishing. EWG 11-12 recommends that fishing effort to be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

It is important to consider that this stock could be strongly affected by environmental and ecological factors (e.g. water temperature, predation).

6.10 Stock assessment of pink shrimp in GSA 09

6.10.1 Stock identification and biological features

6.10.1.1 Stock Identification

Due to a lack of information about the structure of pink shrimp population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries.

The species shows a wide bathymetric distribution in the GSA 09, being present from 50 to 650 m depth with greatest abundance between 150 and 400 m depth over muddy or sandy-muddy bottoms (Ardizzone and Corsi, 1997; Biagi *et al.*, 2002).

The highest abundances have been found in the Tyrrhenian part of the GSA (south Tuscany and Latium).

Recruits (CL ≤ 15 mm) occur all year round with a main peak from July to October (De Ranieri *et al*., 1997). The main nurseries revealed a high spatio-temporal persistency (Fig. 6.10.1.1.1) between 60 and 220 m depth. The core of nursery areas overlap with crinoid beds (*Leptometra phalangium*) areas over the shelf-break (Colloca *et al*., 2004, 2006a; Reale *et al*., 2005). This is a peculiar habitat in the GSA 09 which is also an essential fish habitat for other commercially important species as the European hake, *Merluccius merluccius*. A positive size-depth distribution was found with an increased abundance of larger females with depth (Ardizzone *et al*., 1990).

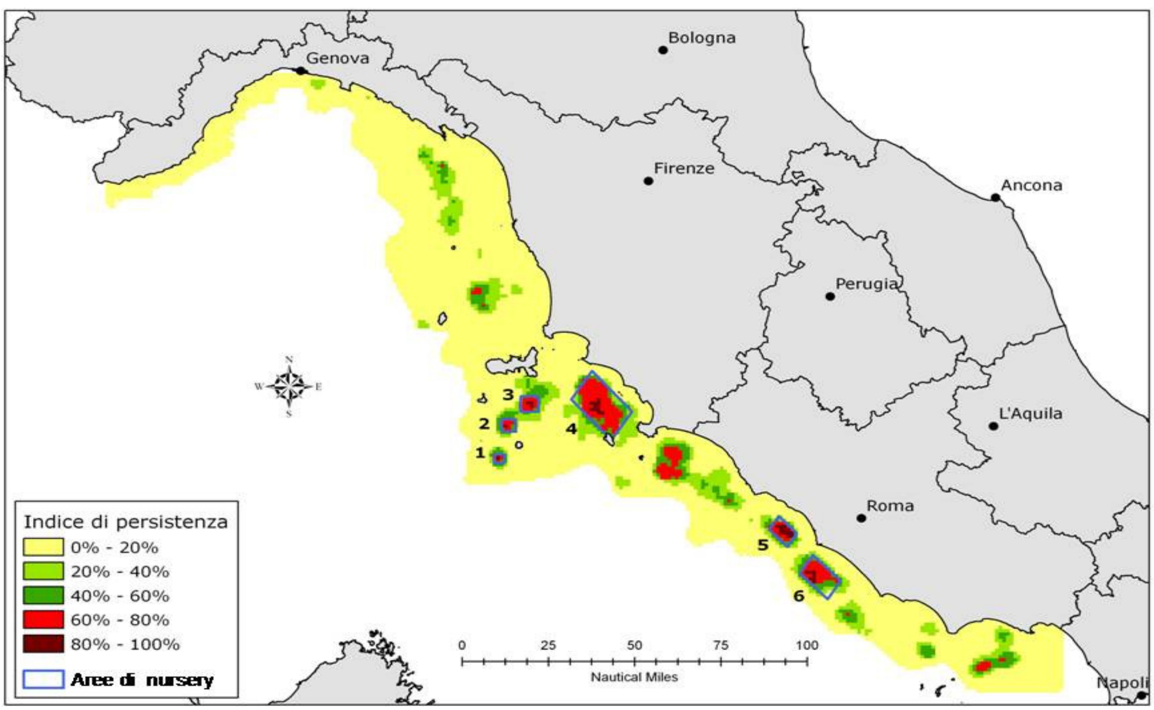


Fig. 6.10.1.1.1 Temporal persistence of *P. longirostris* nurseries in the GSA 09.

6.10.1.2 Growth

The growth of *P. longirostris* has been studied in the southern part of the GSA 09 (central Tyrrhenian Sea) using modal progression analysis (Ardizzone *et al*., 1990). The following sets of Von Bertalanffy growth parameters were estimated: Females: $L\infty = 43.5$, $K=0.74$, $t_0=-0.13$; Males: $L\infty = 33.1$, $K=0.93$, $t_0=-0.05$. The life cycle is of 3-4 years. Females grow faster than males attaining larger size-at-age.

P. longirostris diet is composed of a great variety of organisms; the prey items consisted mostly of external skeletons of bottom organisms, always crushed and often in an advanced state of deterioration. Crustaceans dominated the diet both qualitatively and quantitatively; they were characterized by a high abundance of peracarids, mainly represented by mysids (*Lophogaster typicus*) and amphipods (Lysianassidae). Molluscs (juvenile bivalves and gastropods), cephalopods (Sepiolids), small echinoderms, annelids, small fishes, foraminiferans, (Globigerinidae) and organic detritus are other important food item in the diet of the species (Mori *et al*., 2000b).

6.10.1.3 Maturity

In the northern Tyrrhenian Sea, the reproduction area of *P. longirostris* is located from 150 to 350 m; mature females are present all year round, even though the species shows two peaks in reproductive activity, one in spring and another at the beginning of autumn (Mori *et al*., 2000a). In the central Tyrrhenian Sea, the southern part of GSA 09, a main winter spawning was hypothesized (Ardizzone *et al*., 1990). The size at onset of sexual maturity estimated for different years in northern Tyrrhenian Sea is about 24 mm CL (Mori *et al*., 2000a).

The number of oocytes in the ovary was related to the size of the females and ranged from 23,000 oocytes at 26 mm CL to 204,000 at 43 mm CL. An exponential relationship was observed between fecundity and carapace length: Fecundity = 0.0569 CL4.0177 (r = 0.829) (Mori *et al*., 2000a).

6.10.2 Fisheries

6.10.2.1 General description of fisheries

In the GSA 09 the deep water pink shrimp is one of the most important target species of the fishery carried out on the shelf break and upper part of continental slope. The species is exclusively exploited with otter bottom trawling.

The fishing grounds are located in the southern part of the GSA 09, to the south of Elba Island (northern and central Tyrrhenian Seas); they are mainly exploited by several trawlers of Porto Santo Stefano, Porto Ercole, Fiumicino, Terracina and Gaeta. *P. longirostris* belongs to a fishing assemblage distributed from 150 to 350 m depth, where the main target species are hake, *Merluccius merluccius*, horned octopus, *Eledone cirrhosa* and Norway lobster, *Nephrops norvegicus*, at greater depths (Biagi *et al.*, 2002; Colloca *et al*., 2003; Sartor *et al*., 2003; Sbrana *et al*., 2006).

The majority of bottom trawlers of GSA 09 operate daily fishing trips with some vessels (especially those of Porto Santo Stefano) staying out for two-three days and mainly in the summer. The mean number of fishing days/year per vessel carried out by the GSA 09 trawlers varied from 187 in 2004 to 177 in 2006. Due to the distance of the fishing grounds to the main harbours, fishing activity targeting *P. longirostris* shows some seasonal variations, with maxima from mid spring to mid-autumn.

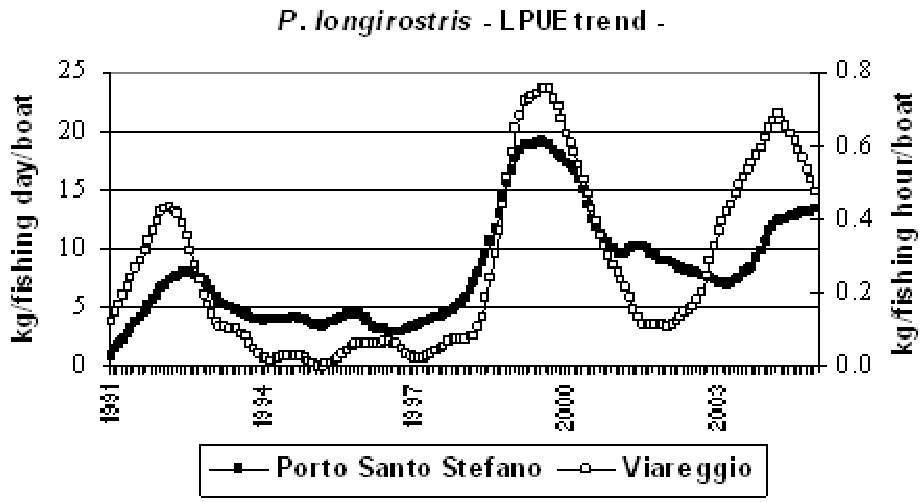


Fig. 6.10.2.1.1 *P. longirostris* LPUE of P. S. Stefano and Viareggio trawlers since 1991 (bottom).

The size structure of the landings, according to the DCR data, shows that the most exploited sizes ranged from 24 to35 mm CL (Fig. 5.34.2.1.2); the presence of specimens under the MLS (20 mm CL) is negligible. According to the growth pattern of the species, fishing exploits mainly 1^+ - 3^+ age classes.

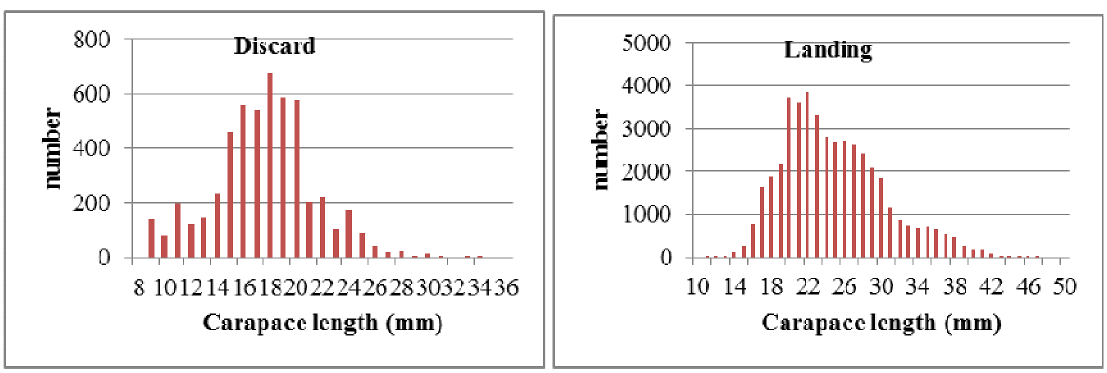


Fig. 6.10.2.1.2 Length frequency distribution of *P. longirostris* landed in the GSA 09 in 2010.

6.10.2.2 Management regulations applicable in 2010 and 2011

The minimum legal landing size is 20 mm Carapace Length (EC regulation 1967/2006). The other management regulations are the same described for hake in the GSA 09.

6.10.2.3 Catches

6.10.2.3.1 Landings

Total landings of deep water rose shrimps fluctuated from 161 tons in 2002 to 254 tons in 2008, showing a peak in 2010 corresponding to 463 tons (Fig. 6.10.2.3.1.1; Tab. 6.10.2.3.1.1). The landings were mainly taken by demersal otter trawlers. The fluctuating trend is a proper characteristic of the landings of this stock, as shown by the LPUE produced by the fleets of Porto Santo Stefano and Viareggio in the period 2001-2005 (Sartor *et al*., 2005) (Fig. 5.34.2.1.1). The values of the two fleets showed the same temporal pattern with maxima in 1992, 1999 and 2004.

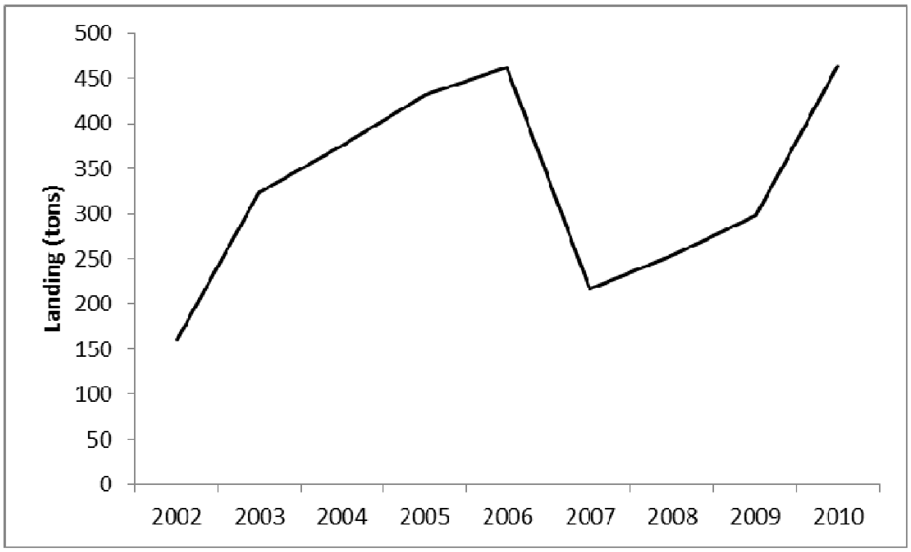


Fig. 6.10.2.3.1.1 Total landings in GSA 09.

Tab. 6.10.2.3.1.1 Annual landings (t) by fishing technique in GSA 09 as provided through the official DCF data call 2011.

SPECIES	COUNTRY	FT_LV4	2002	2003	2004	2005	2006	2007	2008	2009	2010
DPS	ITA	OTB	133	308	367	430	462	215	253	298	463
DPS	ITA	PGP		3	8	1		2	1		
DPS	ITA	PMP	19	12							
DPS	ITA	PTS	9		1						
SUM	ITA		161	323	376	431	462	217	254	298	463

6.10.2.3.2 Discards

Discards of *P. longirostris* are generally scarce; according to Sbrana *et al*. (2006). They ranged from 36.7 tons in 2009 corresponding to 11% of the total catch and to 5% of the total catch in 2010 (36.7 tons).

Discards occurred mainly on the fishing grounds located at depths of less than 200 m, where juvenile specimens are more abundant. About 9 tons of discards were reported to SGMED-09-02 for 2006.

6.10.2.4 Fishing effort

The fishing capacity of the GSA 09 has shown in these last 10 years a progressive reduction; from 1996 to 2010. The total fishing days carried out by all the GSA 09 trawlers decreased from about 65,000 in 2004 to about 63,000 in 2006, also as effect of a reduction from 187 to 177 in the mean number of fishing days/year. The same reduction pattern was observed in the Kw*days at sea either for trawlers (OTB) and fixed nets (GNS and GTR) as showed by Fig. 6.10.2.4.1.

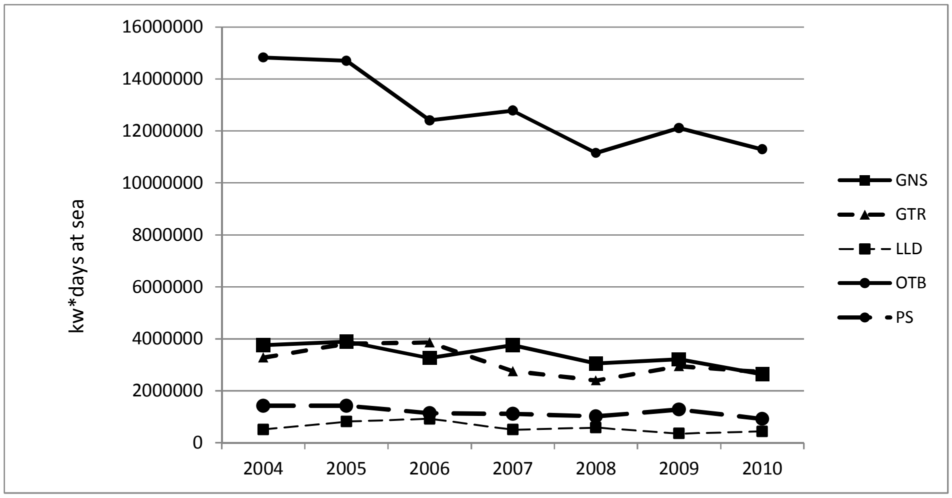


Fig. 6.10.2.4.1 Effort trends (days and kW*days) by major fleets, 2004-2010.

Tab. 6.10.2.4.1 Trends in annual fishing effort (kW*days) by fishing technique deployed in GSA 09, 2004-2010.

Type FT - LVL4	2004	2005	2006	2007	2008	2009	2010
GNS	3758318	3902723	3260681	3755597	3054945	3216541	2641506
GTR	3281736	3814641	3861674	2760530	2403569	2948897	2719155
LLD	510386	821542	927993	507078	585762	358051	434722
OTB	14824084	14700599	12404787	12780491	11149391	12107652	11291098
PS	1424338	1426304	1146586	1116579	1017985	1283965	920985

6.10.3 Scientific surveys

6.10.3.1 MEDITS

6.10.3.1.1 Methods

From 1994 MEDITS survey is regularly carried out each year in spring. The Italian national survey (GRUND), was carried out in autumn for 1994 to 2007. The two surveys gave a similar temporal increasing trend in density and biomass of deep water pink shrimp, even though large fluctuations are present from year to year (Figs. 6.10.3.1.1.1 and 6.10.3.1.3.1). A similar increasing trend in abundance has been observed also in other Italian geographic subareas and could be related to the warming trend in water temperature. *P. longirostris* is a thermophile species that could benefit by the ongoing climatic change in the Mediterranean region. The relationship between environmental variability and deep-sea pink shrimp population dynamic has not been investigated yet.

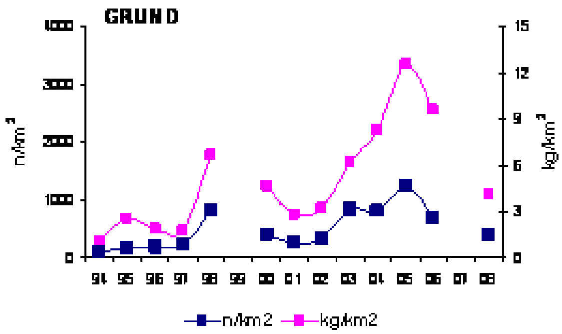


Fig. 6.10.3.1.1.1 *P. longirostris*: GRUND trends in density and biomass from 1994 to 2008 in GSA 09.

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls was reported per depth stratum (s. Tab. 6.10.3.1.1.1).

Tab. 5.34.3.1.1.1. Number of hauls per year and depth stratum in GSA 09, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA09_010-050	21	20	20	20	21	20	20	19	15	14	15	16	15	15	16	16	15
GSA09_050-100	21	21	20	20	20	21	22	23	17	18	17	16	18	18	16	16	19
GSA09_100-200	38	40	40	40	39	39	38	38	30	30	30	31	29	30	31	31	29
GSA09_200-500	40	40	42	42	41	41	42	41	32	33	36	35	36	37	34	34	35
GSA09_500-800	33	32	31	31	32	32	31	32	26	25	22	22	22	20	23	23	22

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area

Ai=area of the i-th stratum

si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.10.3.1.2 Geographical distribution patterns

The stock is more abundant in the southern part of the GSA (Tyrrhenian Sea) as showed in Figure 6.10.3.1.2.1.

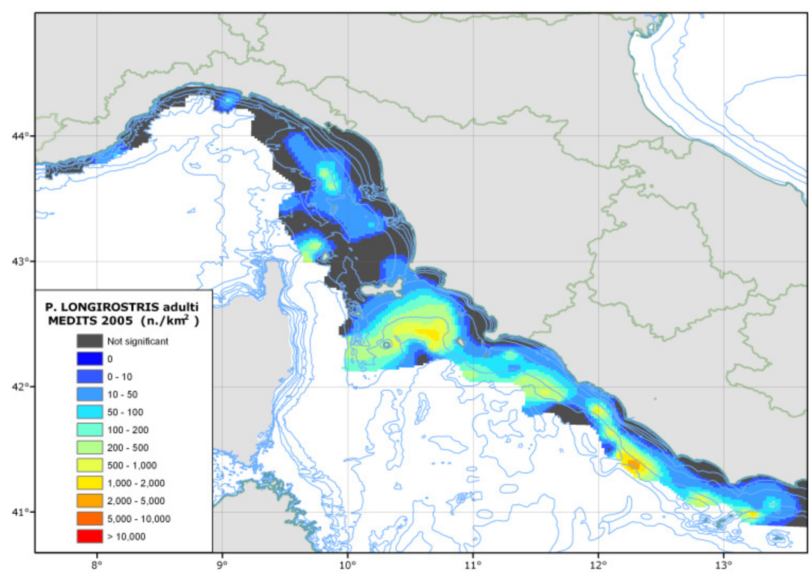


Fig. 6.10.3.1.2.1 *P. longirostris* distribution pattern of adults in GSA 09 in 2005.

6.10.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the pink shrimp in GSA 09 was derived from the international survey MEDITS. Figure 6.10.3.1.3.1 displays the estimated trend in pink shrimp abundance and biomass in GSA 09.

The estimated abundance and biomass indices reveal a clear growing trend since 2000 with an abrut increase in the last 4 years.

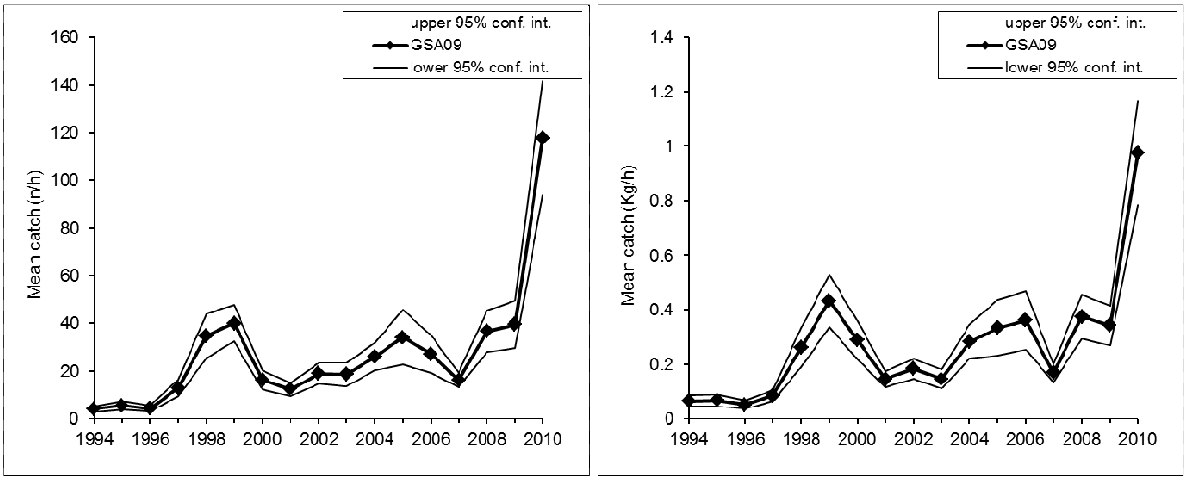


Fig. 6.10.3.1.3.1 Abundance and biomass indices of pink shrimp in GSA 09 (MEDITS 1994-2010).

6.10.3.1.4 Trends in abundance by length or age

The following Fig. 6.10.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2010.

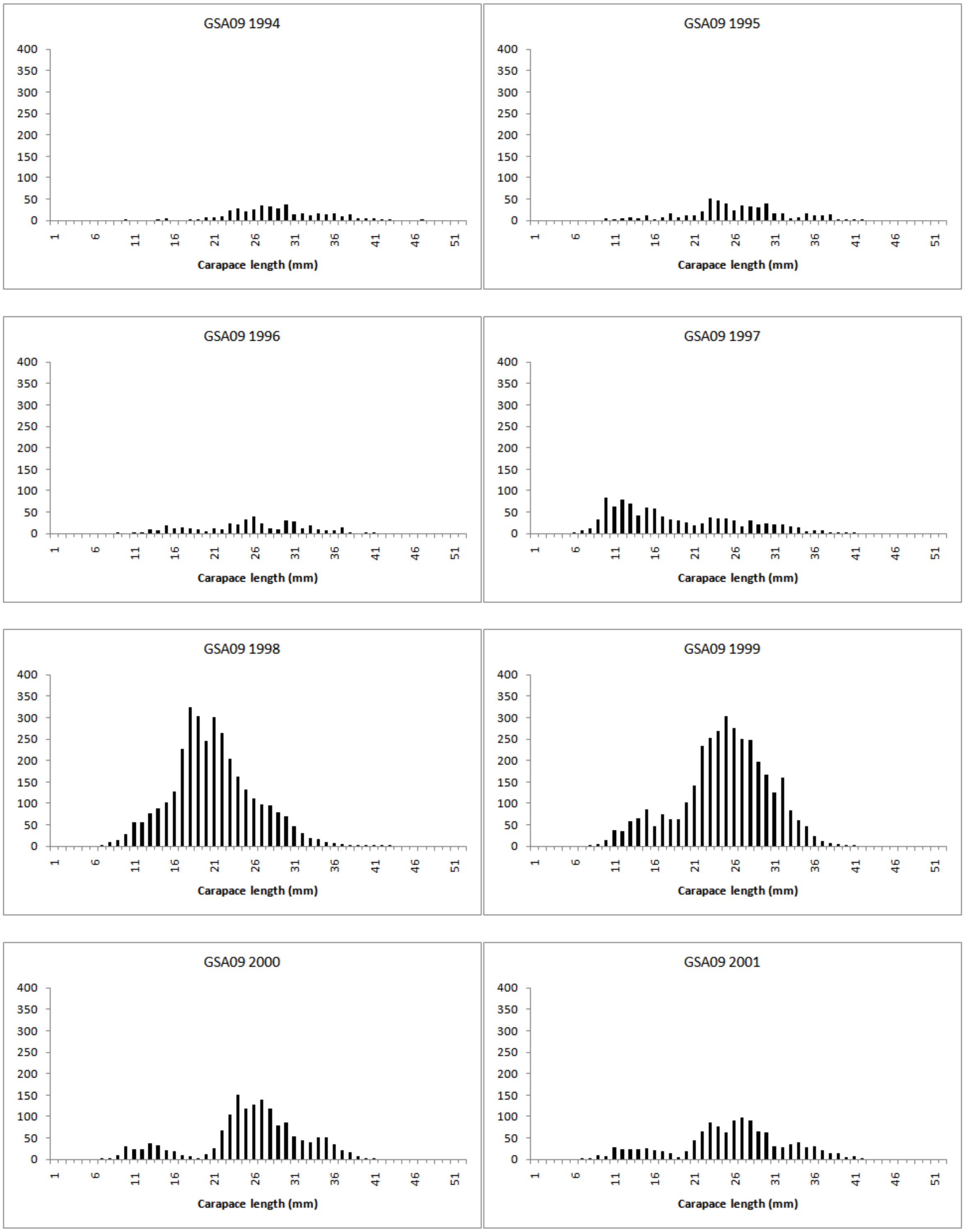
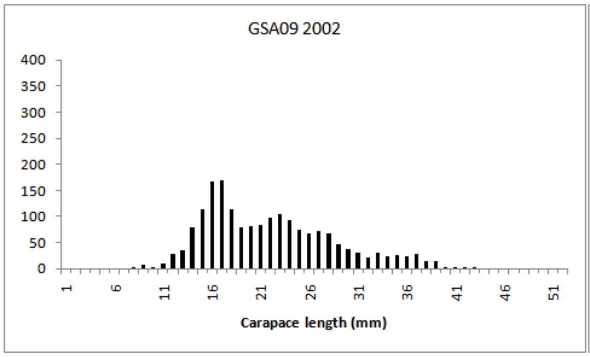


Fig. 6.10.3.1.4.1 Stratified abundance indices by size, 1994-2001.


GSA09 2002
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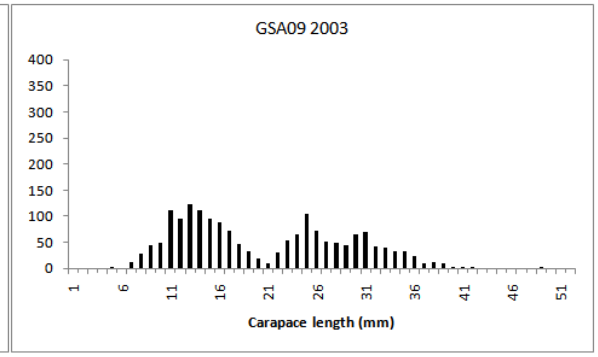
Carapace length (mm)

GSA09 2003
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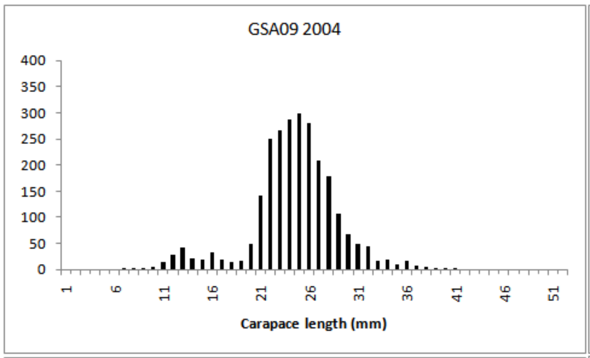
Carapace length (mm)

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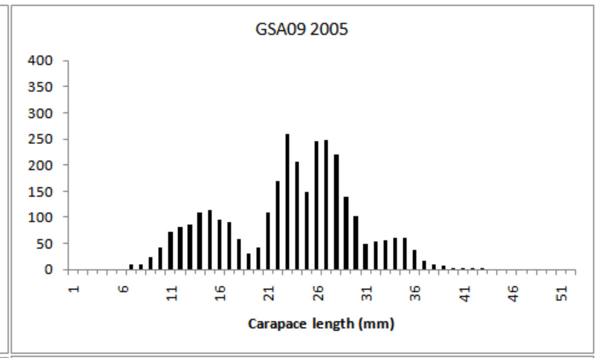
Carapace length (mm)

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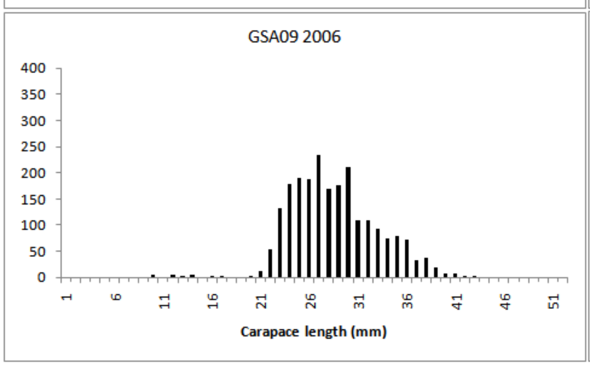
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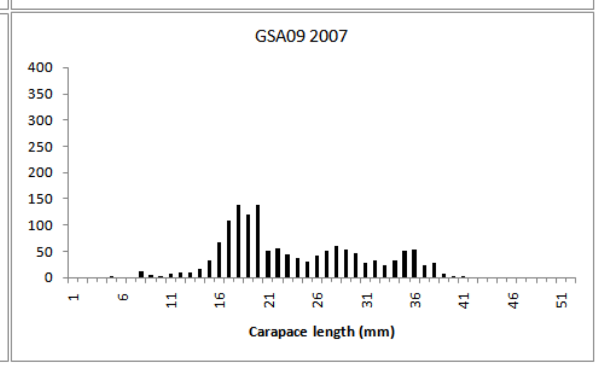
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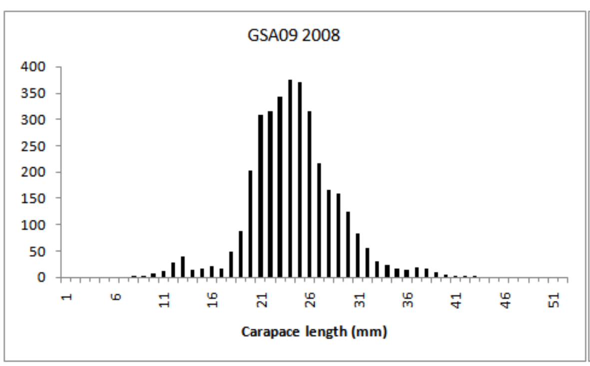
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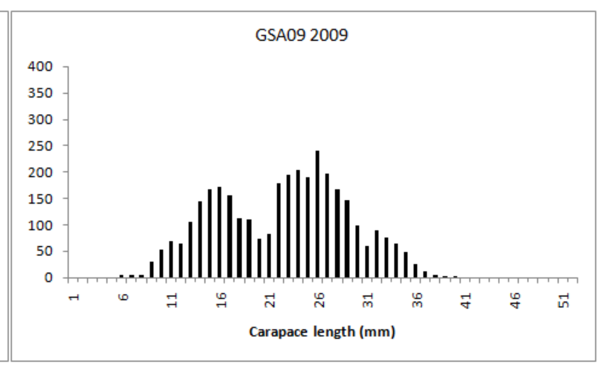
Carapace length (mm)

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Carapace length (mm)

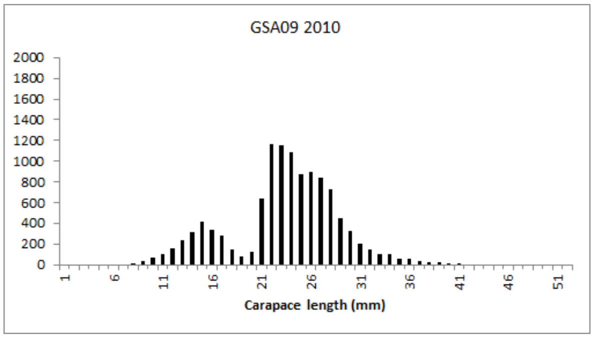


Fig. 6.10.3.1.4.2 Stratified abundance indices by size, 2002-2010.

6.10.3.1.5 Trends in growth

No analyses were conducted during EWG 11-12.

6.10.3.1.6 Trends in maturity

No analyses were conducted during EWG 11-12.

6.10.4 Assessment of historic stock parameters

6.10.4.1 Method 1: SURBA

6.10.4.1.1 Justification

The MEDITS survey provided the longer standardized time-series data on abundance and population structure of *P. longirostris* in the GSA 09.

6.10.4.1.2 Input parameters

The survey-based stock assessment model SURBA (Needle, 2003) was used to reconstruct trend in population structure and fishing mortality.

The following set of input data and parameters were used (Tab. 6.10.4.1.2.1 and 2).

Tab. 6.10.4.1.2.1 Input data used in the SURBA model.

MEDITS

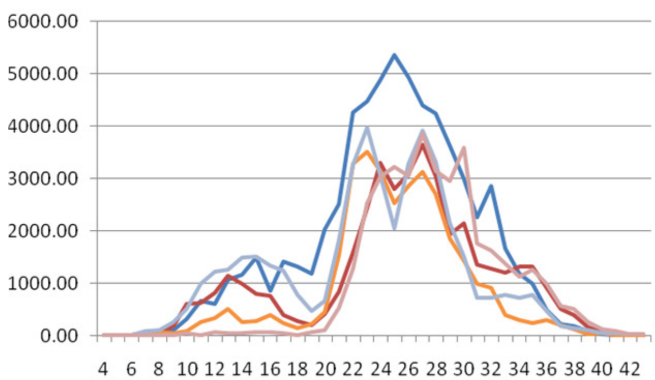
Mean abundance					Mean weights				
	Age					Age			
Year	0	1	2	3+	Year	0	1	2	3+
1994		26.0	9.7	3.0	1994		15.5	18.1	25.1
1995		33.8	7.1	2.5	1995		15.1	18.0	24.7
1996		22.6	7.1	1.6	1996		16.5	18.1	25.0
1997		33.2	7.8	1.0	1997		13.8	17.4	24.6
1998		132.8	9.4	0.9	1998		15.8	17.1	24.9
1999		253.7	45.7	1.9	1999		15.9	17.2	24.0
2000		155.6	39.6	3.7	2000		14.7	18.0	23.8
2001		73.2	18.8	3.9	2001		14.7	18.2	24.6
2002		70.1	17.4	4.0	2002		16.0	18.0	24.2
2003		58.1	17.3	2.5	2003		14.9	17.6	24.3
2004		186.9	16.5	1.4	2004		14.7	17.1	23.8
2005		216.3	29.7	2.4	2005		14.9	18.0	24.7
2006		209.5	53.6	7.7	2006		16.5	17.8	24.4
2007		57.9	26.0	4.0	2007		17.2	18.5	23.8
2008		260.7	16.4	3.7	2008		17.2	18.5	23.8
2009		278.7	64.5	3.6	2009		16.5	17.8	24.4
2010		1214.7	79.52	9.28	2010		8.6	17.1	24.8

Proportion mature				
	Age			
Year	0	1	2	3+
1994		0.8	1	1
1995		0.8	1	1
1996		0.8	1	1
1997		0.8	1	1
1998		0.8	1	1
1999		0.8	1	1
2000		0.8	1	1
2001		0.8	1	1
2002		0.8	1	1
2003		0.8	1	1
2004		0.8	1	1
2005		0.8	1	1
2006		0.8	1	1
2007		0.8	1	1
2008		0.8	1	1
2009		0.8	1	1
2010		0.8	1	1

Tab. 6.10.4.1.2.2 Input parameters used in the SURBA model.

• **Growth**
L∞ = 43.5 mm carapace length
K = 0.6
to = 0
• **Length-Weight relationhips**
a = 0.00686
b = 2.24
• **Natural mortality**
M = 1..0 (age 0), 0.78 (age 1), 0.69 (age 2), 0.65 (age 3) (ProdBiom)
• **Length-at-maturity (L50)**
L50 = 24 mm
Lc100 = 20 mm

Standardized time series of MEDITS length-frequency-distributions were sliced into different age-groups using the same growth parameters for the whole time series (Fig. 6.10.4.1.2.1). The resulting age structures showed a very high internal consistency, thus showing the reliability of the growth parameters used (Fig. 6.10.4.1.2.1).



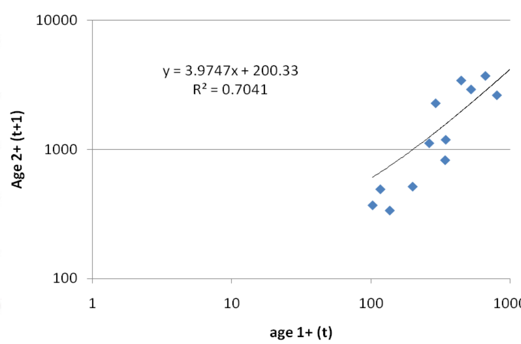


Fig. 6.10.4.1.2.1 Length frequency distributions of *P. longirostris* for 2000 to 2005 (left). Relationship between the estimated shrimp abundance at age 1 (time t) and age 2 (time t+1) (right).

A preliminary attempt to use SURBA was made excluding 0+ (CL < 20mm) specimens from the dataset due to their low catchability with the MEDITS trawl net

6.10.4.1.3 Results

Fitted year effect shows strong fluctuations from year to year with a decrease since 2006, while the age effect shows a flat-topped selection pattern for stock mortality with an increase from age 3 to age 6. Fitted cohort effects (Figure 6.10.4.1.3.1) are high in recent years.

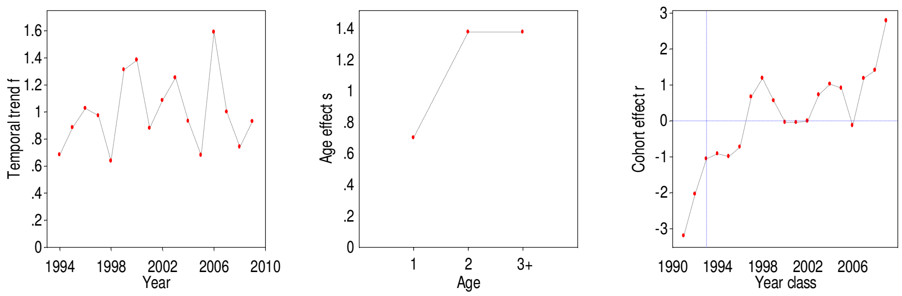


Fig. 6.10.4.1.3.1 MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

Average mortality ($F_{1\text{-}3}$) estimated from MEDITS ranged between 0.63 (1994) and 1.8 (2008) and was 0.99 in 2009. Relative indices derived from MEDITS survey for the period 1994-2010 indicated large fluctuation with main peaks in 1999, 2006 and 2010. The stock shows a fast increasing since 2007 both in the spawning stock biomass and recruitment. In 2010 the SSB was more than 4 times higher than in 2007 (Fig. 5.34.4.1.3.2).

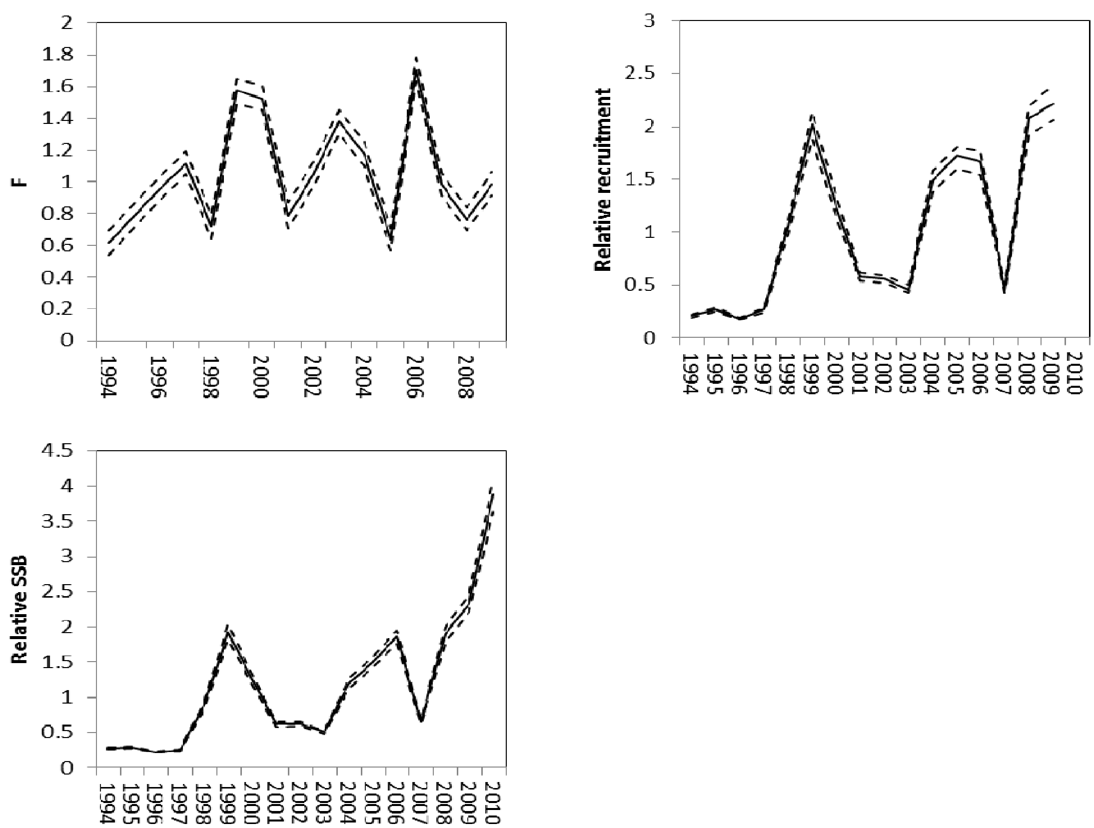
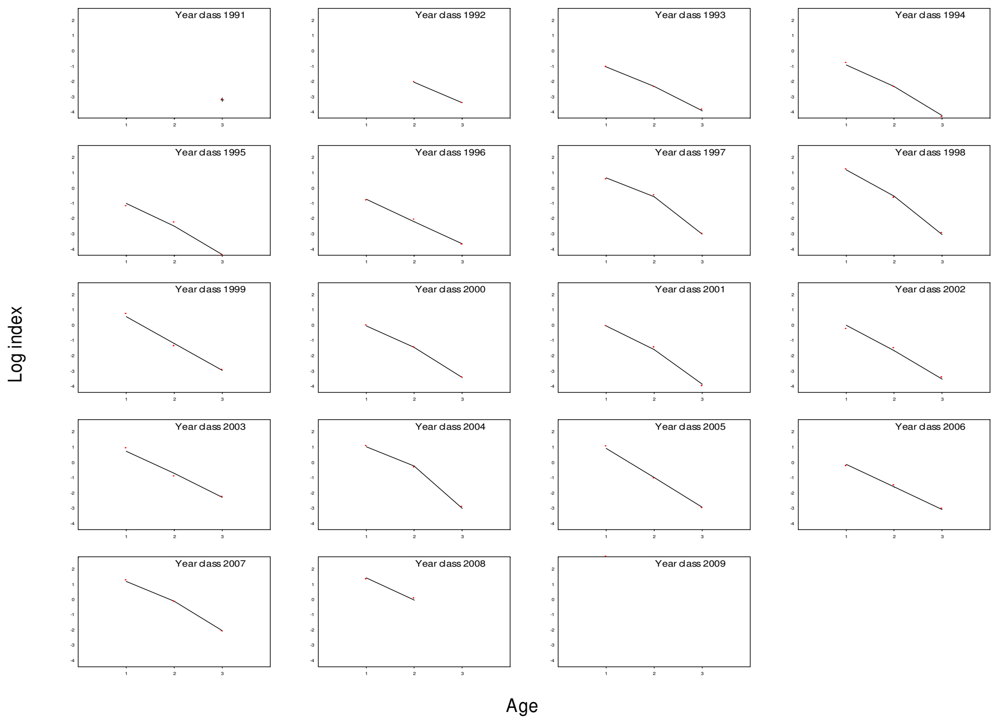


Fig. 6.10.4.1.3.2 Estimated trend in $F_{1\text{-}3}$, relative SSB and recruitment index at age 1+ of *P. longirostris* in the GSA 09, dotted lines are 2.5% and 97.5% confidence intervals.

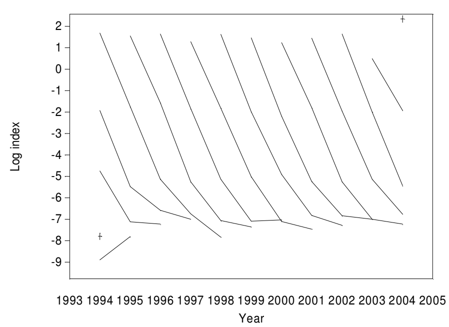
Model diagnostics

The SURBA model for *P. longirostris* fits very well on survey data as showed in Fig. 6.10.4.1.3.3.

A)



B)



C)

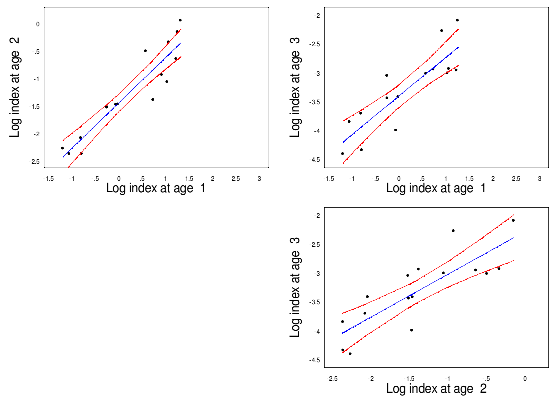


Fig. 6.10.4.1.3.3. Model diagnostic for SURBA model of in the GSA 9. A) Comparison between observed (points) and fitted (lines) MEDITS survey abundance indices, for each year. B) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life. C) Age scatterplots.

6.10.4.2 Method 2: XSA

6.10.4.2.1 Justification

The availability of 5 years of DCF data allow to move from the length cohort analysis (LCA) carried out under the equilibrium assumption to the extended survivor analysis (XSA). The assessment was carried out during EWG 11-12 using landing data collected under DCR from 2006 to 2010 and calibrated with surveys data (MEDITS 2006-2010).

6.10.4.2.2 Input parameters

DCF data for deep sea pink shrimp landings and discards, including numbers at age and maturity at age, were used to compile XSA input data for 2006-2010. Data on the amount and length structure of discards were available for 2006, 2009 and 2010. The discard proportion of the 0 group available for 2006 was used to estimate discard for 2007, while discard data for 2009 were used to estimate the discard proportion in 2008. The same M at age vector adopted for Surba was used (Table 6.10.4.2.2.1).

Tab. 6.10.4.2.2.1. Input data for XSA of deep water pink shrimp in GSA 09.

	Catch-at-age (thousands)				
Age class	2006	2007	2008	2009	2010
0	550	1169	3402	19465	20765
1	15457	10825	11852	12113	25752
2	12364	5211	5072	2617	3005
3	2063	792	912	667	527
4+	467	332	951	1129	738
	Weight-at-age (kg)				
Age class	2006	2007	2008	2009	2010
0	0.001492	0.001488	0.001485	0.001389	0.004002
1	0.009213	0.009028	0.009151	0.00893	0.009362
2	0.017515	0.017289	0.017556	0.01727	0.01756
3	0.023571	0.023472	0.023581	0.023413	0.014115
4+	0.0296	0.0296	0.0296	0.027165	0.028545
	Maturity-at-age				
Age class	2006	2007	2008	2009	2010
0	0	0.8	1	1	1
1	0	0.8	1	1	1
2	0	0.8	1	1	1
3	0	0.8	1	1	1
4+	0	0.8	1	1	1
	Mortality-at-age				
Age class	2006	2007	2008	2009	2010
0	1.00	0.78	0.69	0.65	0.50
1	1.00	0.78	0.69	0.65	0.50
2	1.00	0.78	0.69	0.65	0.50
3	1.00	0.78	0.69	0.65	0.50
4+	1.00	0.78	0.69	0.65	0.50

6.10.4.2.3 Results including sensitivity analyses

XSA was run setting shrinkage at 0.5, 1.0, 2.0. As showed by Fig. 6.10.4.2.3.1. The three different settings produced very different estimates of recruitment and SSB. Model with 1.0 shrinkage was adopted as final model based on the analysis of residual distributions which showed a low trend (from positive residuals in the first two years to negative residuals in 2009 2010 for age groups 2 and 3 (Fig. 6.10.4.1.3.2).

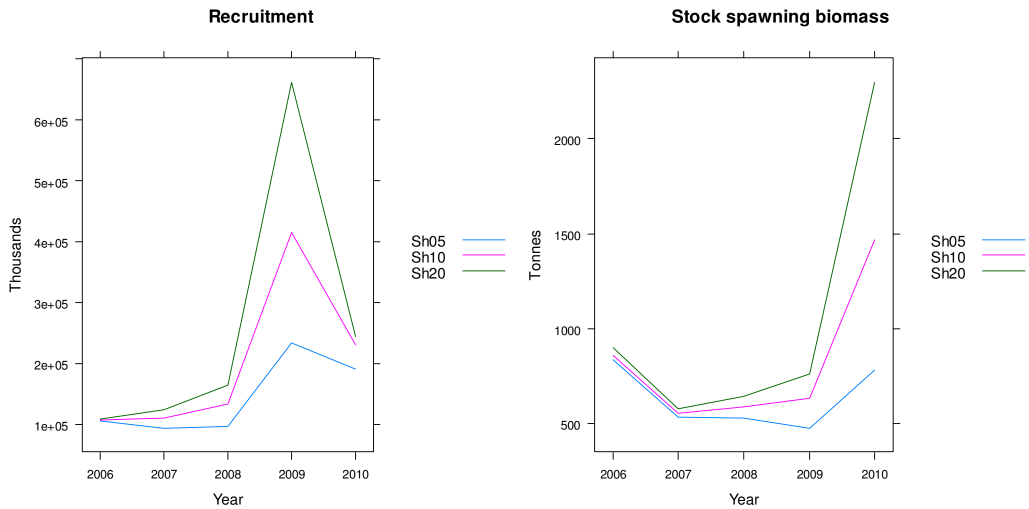


Fig. 6.10.4.2.3.1. Estimates of recruitment and SSB under different shrinkage settings

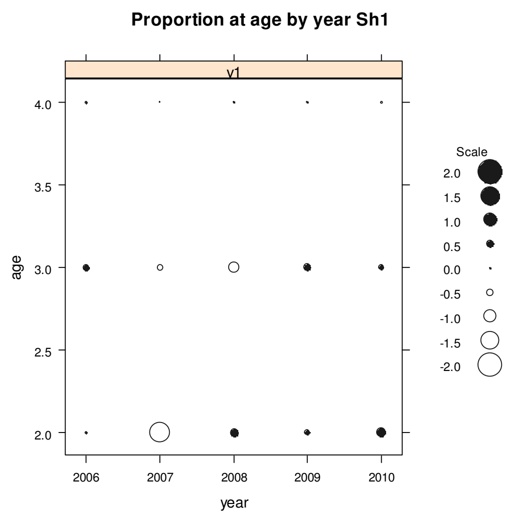


Fig. 6.10.4.2.3.2. Residuals at age obtained with shrinkage set at 1.0.

The following Table 6.10.4.2.3.1 shows the estimates for spawning stock biomass (SSB), total biomass (TB) recruitment as estimated by XSA from 2006 to 2010. The annual yield including discards is also showed.

In 2010 the estimated spawning stock biomass (1467 tons) was more than two times higher than the SSB estimated for 2009 (632.5 tons). Recruitment estimates increased constantly since 2006 peaking in 2009 (415×10^6 recruits) and decreasing in 2010 (231×10^6 recruits).

A similar increasing trend of SSB and recruitment was observed during Medits which also indicated the highest recruitment peak in 2009 and the SSB peak in 2010 (see Fig. 6.10.4.2.3.3).

Table 6.10.4.2.3.1. Spawning stock biomass (SSB), total biomass (TB) and recruitment estimates by XSA for hake in GSA 9 from 2005 to 2010. Fisheries yield is also indicated

	2006	2007	2008	2009	2010
SSB (tons)	860.2	552.5	588.9	632.5	1467.7
Total biomass (tons)	1108.6	788.7	861.0	1292.8	2656.7
Recruitment (millions)	107.4	111.1	133.7	414.8	231.2
Yield (landing)	422	218	252	227	405

The estimates of $F_{1\text{-}3}$-at age and $Fbar_{1\text{-}3}$ are listed in Table 6.10.4.2.3.2 and shown in Fig. 6.10.4.2.3.3. F shows a decreasing trend from 1.26 in 2006 to 0.29 in 2010 as probably determined by the stock size increase observed in the last 5 years. Medits estimates of $F_{1\text{-}3}$-are slightly higher, except in 2008, also indicating a decreasing since 2006 (Fig. 6.10.4.2.3.4).

Table 6.10.4.2.3.2 Fishing mortality and numbers at age at age as estimated by XSA.

F-at-age

age class	2006	2007	2008	2009	2010
0	0.01	0.02	0.04	0.08	0.16
1	0.65	0.52	0.57	0.48	0.31
2	1.67	1.03	1.12	0.44	0.38
3	1.05	0.78	0.95	0.76	0.24
4+	1.05	0.78	0.95	0.76	0.24
$Fbar_{1\text{-}3}$	**1.26**	**0.86**	**1.00**	**0.65**	**0.29**

Numbers at age (thousands)

age class	2006	2007	2008	2009	2010
0	107400	111145	133732	414866	231212
1	47848	39177	40179	47134	140815
2	21500	11468	10630	10394	13405
3	4393	2027	2062	1739	3360
4+	925	802	2011	2780	4563

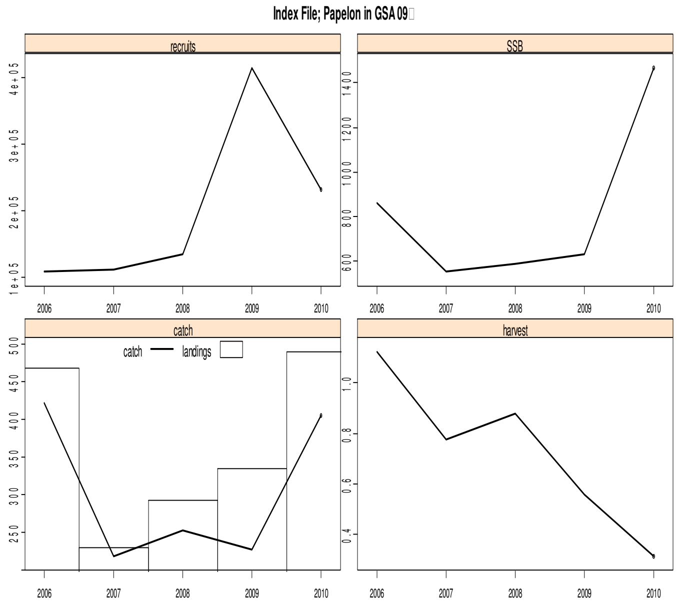


Fig. 6.10.4.2.3.3. Summary of stock parameters of deep sea pink shrimp as estimated by XSA.

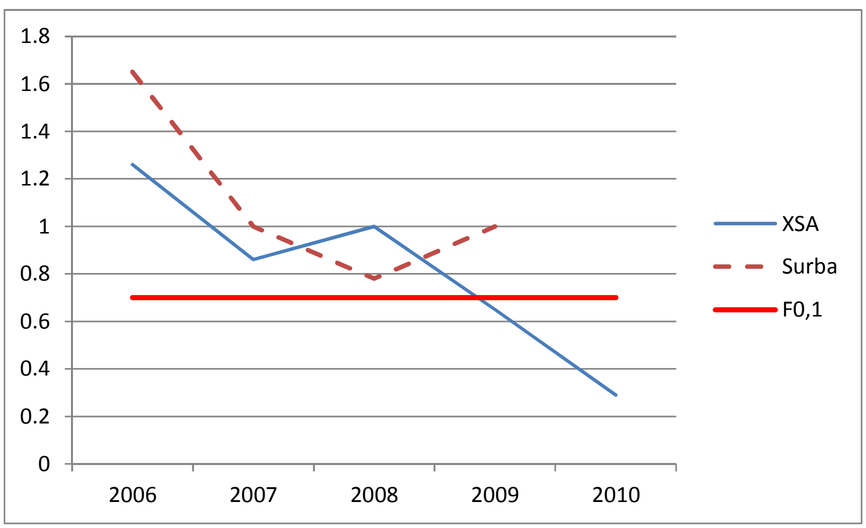


Fig. 6.10.4.2.3.4. Estimates of Fs obtained by means of Surba and XSA as compared with F0.1.

6.10.5 Long term prediction

6.10.5.1 Justification

The Yield software (Hoggarth *et al*., 2006) was used to estimate $F_{0.1}$ as target equilibrium YPR reference point for the stock assuming a 20% uncertainty in parameters estimations.

6.10.5.2 Input parameters

The following parameters were used to estimate $F_{0.1}$ through Yield software.

Tab. 6.10.5.2.1 Input to long term forecast.

L∞ = 43.5 mm carapace length
K = 0.6
t_0 = 0
a = 0.00686
b = 2.24
M = 1.2 CV=0.1
L_{50} = 24 mm, CV=0.05
Lc100 = 20 mm, CV=0.05
Spawning season: March-August
Fishing season: January-December

6.10.5.3 Results

Fig. 6.10.5.3.1 shows the probability distribution of $F_{0.1}$ (1,000 simulations). Uncertainty in model parameters produced considerable variations in $F_{0.1}$ which ranged between 0.5 and 1.1 (mean = 0.7) with the highest probability for values between 0.7 and 0.8.

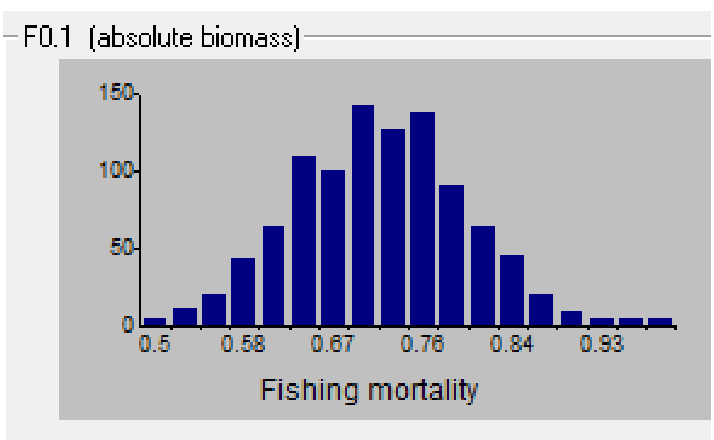


Fig. 5.34.5.3.1 Probability distribution of $F_{0.1}$ obtained using the Yield software.

6.10.6 Data quality

Landing and discard data included in the DCF data available during STECF-EGW 11-12 appeared consistent either as landing and discard annual amounts for the fishing gears exploiting the stock (bottom otter trawl, gillnets and trammel nets) or numbers at age and length. It would be however advisable to add in the next DCF also the proportion in the landings of mature fish and the sex ratio by length and age class that were not included in the data available during STECF-EGW 11-12. The proportion of mature fish by length/age class is one of the input required for the assessment. The sex ratio it is necessary to evaluate the consistency of the catch at age data provided slicing the length distribution data for the two sexes separately.

6.10.7 Scientific advice

6.10.7.1 Short term considerations

6.10.7.1.1 State of the spawning stock size

Survey index of SSB and XSA estimates showed a rapid increasing pattern since 2007 with a high peak in 2010. In the absence of a precautionary biomass reference point STECF EWG 11-12 is unable to fully evaluation the stock size status.

6.10.7.1.2 State of the spawning stock size

Recruitment is indicated to have increased over time and a strong year class was observed in 2009 (424.8 millions). Both landings and survey data confirm this positive trend. Relative indices for age 1+ from survey data indicated a general increasing trend since 1994 with three main recruitment peaks in 1999, 2005 and 2009. In 2009 recruitment at age 1 (MEDITS) was 180% of the short term average (2005-07).

6.10.7.1.3 State of exploitation

STECF EWG 11-12 proposes $F_{0.1}$=0.7 as limit management reference point consistent with high long term yield and low risk of fisheries collapse.

The F estimates by means of XSA display a decreasing trend during the investigated period (2006-2010). In the 2010, the F_{1-3} is well below the estimated reference value of $F_{0.1}$=0.7.

STECF EWG 11-12 advice relies on the XSA and considers the stock has been harvested sustainably. It is important to consider that this stock could be strongly driven by environmental and ecological factors (e.g. water temperature, predatory release effect).

6.11 Stock assessment of the giant red shrimp in GSA 09

6.11.1 Stock identification and biological features

6.11.1.1 Stock Identification

Due to a lack of enough information about the structure of giant red shrimp in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries.

The giant red shrimp *Aristaeomorpha foliacea* is mainly to be found in the epibathyal and mesobathyal waters of the western Mediterranean

In the GSA09*, A. foliacea* is more abundant in the Central Tyrrhenian (Ardizzone *et al.*, 1994) while lower concentrations are present in the Northern Tyrrhenian (VV. AA., 1990) and in the Ligurian Sea, where this species considerably over time (Orsi Relini and Relini, 1985).

6.11.1.2 Growth

In general the length-frequency distributions have a polymodal pattern, with 4-5 components for females (adult modes of are less defined) and 2 components for males (Leonardi and Ardizzone, 1994).

Analysis on the size structure histograms relating to the central-southern Tyrrhenian shown, particularly in spring, a highly differentiated structure. Both males and females are present in the young classes, with a certain prevalence of the latter. In the range from 32 to 38 mm a mode composed solely of males appears, and over 42 mm distribution is composed solely of females. This characteristic highlights a different mode of growth of the two sexes.

In the last decade different set of growth parameters were estimated for *A. foliacea* in the Tyrrhenian sea (Leonardi et al., 1994) but in this analysis were used the set of parameters obtained in the REDS project (FISH/2004/03-32) for the male and from the analysis of size distributions data gathered during GRUND surveys carried out in the GSA09 for female.

The feeding of red shrimps (*A. foliacea, A. antennatus*), studied by Brian (1931) in the Ligurian sea, indicated the euryphagous feeding behaviour of the two species which alternate phases of active hunting with phases in which they consume small benthonic prey (Lagardere, 1972).

Red shrimps obtain food from an area of the sea which extends vertically for several hundred metres (Orsi Relini, 1984). Their diet includes both organisms from the muddy bed and herbivorous organisms which use surface plankton. The former include *Ophiocten abyssicolum*, which is probably useful to the shrimps as a source of calcium with which to build their exoskeleton. The latter include the shrimps of the genuses *Pasiphaea, Sergestes* and the *Eufasiacean Meganyctiphanes norvegica*. In the night these prey move up to the surface waters for feeding needs, while during the day they remain near the sea bed (Orsi Relini and Wurtz, 1977). *A. foliacea* is quite voracious, possibly due to needs imposed by the rapid maturing of the eggs, and is also capable of attacking shrimps of the *Plesionika* genus which can even measure up to 2/3 the size of the aggressor. Food characteristics of this type could entail a greater vulnerability of this species in an altered marine ecosystem (Orsi Relini, 1984).

6.11.1.3 Maturity

The reproduction period of *A. foliacea* lasts from May to September, with a peak in the summer (July-August). Four stages of ovary maturity were described by using a macroscopic colorimetric scale (Levi and Vacchi, 1989) and the mature ovaries can be recognised because initially they are grey coloured, with increasingly dark shades until they become black, due to the presence of carotenoproteins (Orsi Relini and Semeria, 1983).

Mature females are concentrated in the mesobathyal bottoms from spring to autumn. The fertility of *A. foliacea* has been estimated as being equal approximately to 1/3 of the fertility of *A. antennatus* (Orsi Relini and Semeria, 1983). Analyses of the ultrastructure of the ovary indicated cells arranged in a line. *A. foliacea* has a dome-shaped thelycum and characteristics which can be compared to those of decapod crustaceans with a closed thelycum, with coupling coinciding with the moult phases (Orsi Relini L., in VV. AA., 1997). In males the spermatophore originates by passing through the deferent duct, and the spermatic mass is contained in a chamber with "wings" at the edge that serve a protective purpose.

In the Northern Tyrrhenian (Righini and Abella, 1994) the smallest female with spermatophore had a carapace length (CL) of 40 mm. In the Central Tyrrhenian (southern Tuscan Archipelago), the smallest mature female measured 28 mm (CL), and the smallest mature male 29 mm (CL) (Mori et al., 1994). Mature males were observed all year round. In the Central Tyrrhenian (Latium), the size at first maturity is 30-31 mm for males and the smallest female with spermatophore measured 33 mm (Leonardi and Ardizzone, 1994).

6.11.2 Fisheries

6.11.2.1 General description of fisheries

In the GSA09 the giant red shrimp, *Aristaeomorpha foliacea*, is one of the most important target species of the otter bottom trawl fishery carried out on the muddy bottoms of the upper and middle slope. The main fishing grounds are located in the central and southern part of the GSA09 (eastern Ligurian Sea, northern and central Tyrrhenian Sea). The species is mainly exploited by the trawl fleets of Porto S. Stefano and Porto Ercole, in Tuscany, and Fiumicino, Anzio, and Terracina, in Latium.

As an example, Fig. 6.11.2.1.1 shows the landings per unit of effort (LPUE, kg/vessel/day) by the Porto S. Stefano trawl fleet, which is one of the fleets historically targeting the giant red shrimp in the GSA 09. Seasonality fluctuations are a proper characteristic of the landings of this species, as shown by the LPUE produced by the fleet of Porto S. Stefano in the period 1991-2010. The highest catch rates are observed in late spring-summer; even though peaks due to recruitment and other biological aspects do exist, the main factor affecting this seasonal pattern is the spatial distribution of the fishing effort. In fact, the fishing grounds where the giant red shrimp is targeted are distant from the coast, thus this fishery is strongly influenced by the weather conditions (Sartor et al., 2003; Sbrana et al., 2003).

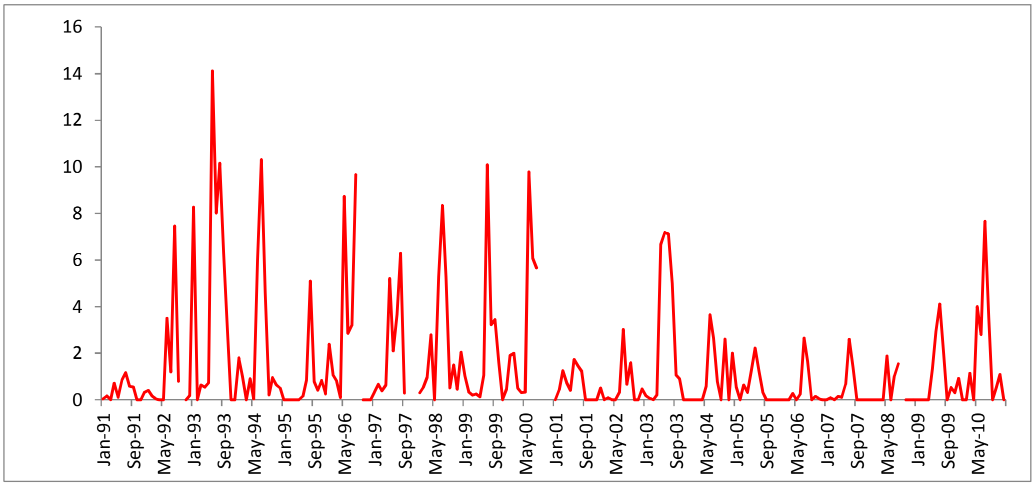


Fig. 6.11.2.1.1 *A. foliacea* LPUE of Porto Santo Stefano from January 1991 to May 2010.

The age structure of the landings, according to the DCR data, shows that the catch ranged between the age classes 1+ and 5+ (Fig.6.11.1.2.1.2).

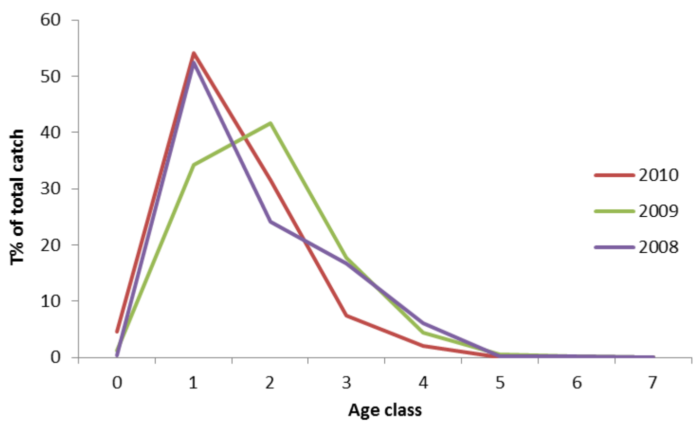


Fig.1.1.2.1.2 Age frequency distribution of *A. foliacea* landed in the GSA 09 from 2008 to 2010.

6.11.2.2 Management regulations applicable in 2010 and 2011

EC regulation 1967/2006 don't provide for a minimum length size for this species. Italian national law provided in the last years a fishing ban of a month which, for the Ligurian fleet, is enforced after the summer fishing season.

6.11.2.3 Catches

6.11.2.3.1 Landings

Total landings of giant red shrimps decreased from about 60 tons in 2006 to 37 tons in 2007, in 2008 and

2009 landings remain quite stable and then an increasing up to about 55 tons was observed in 2010 (Fig. 6.11.2.3.1.1; Tab. 6.11.2.3.1.1). The landings are entirely taken by OTB fleets.

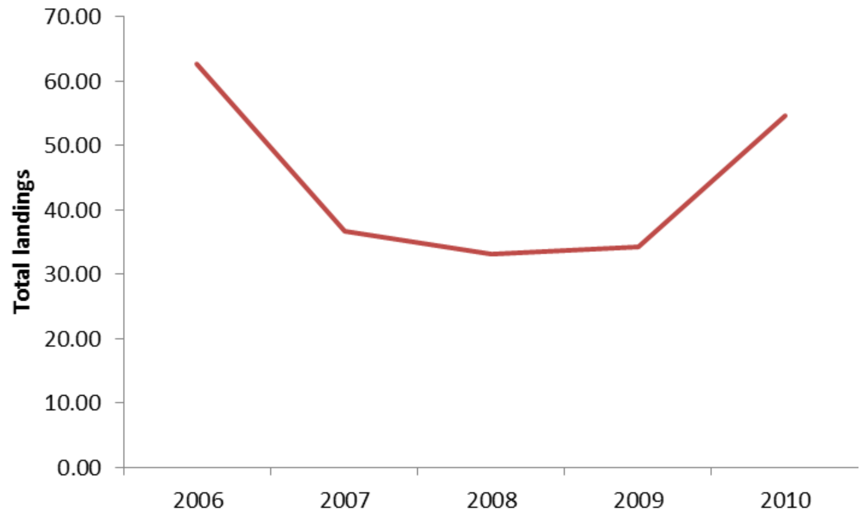


Fig. 6.11.2.3.1.1 Total landings by gear in GSA 09.

Tab. 6.11.2.3.1.1 Annual landings (t) by fishing technique in GSA 09 as provided through the official DCF data call 2011.

COUNTRY	YEAR	GEAR	AREA	SPECIES	LANDINGS
ITA	2006	OTB	SA 9	ARS	62.61
ITA	2007	OTB	SA 9	ARS	36.65
ITA	2008	OTB	SA 9	ARS	33.13
ITA	2009	OTB	SA 9	ARS	34.29
ITA	2010	OTB	SA 9	ARS	54.55

6.11.2.3.2 Discards

Discarding of *A. foliacea* was not observed.

6.11.2.4 Fishing effort

The trends in fishing effort by fishing technique are listed in Tab. 6.11.2.4.1. From 2006 to 2009 the effort decreased, while in the last year a slightly increase was detected (Figure 6.11.2.3.3.1).

Tab. 6.11.2.4.1Trends in annual fishing effort as nominal effort (kW*days) and GT*days at sea deployed in GSA09 from 2006 to 2010.

COUNTRY	AREA	YEAR	GEAR	NOMINAL EFFORT	GT DAYS AT SEA
ITA	SA9	2006	OTB	9432075	1746412
ITA	SA9	2007	OTB	8404088	1433624
ITA	SA9	2008	OTB	2792267	545085
ITA	SA9	2009	OTB	2571948	446688
ITA	SA9	2010	OTB	3603156	668052

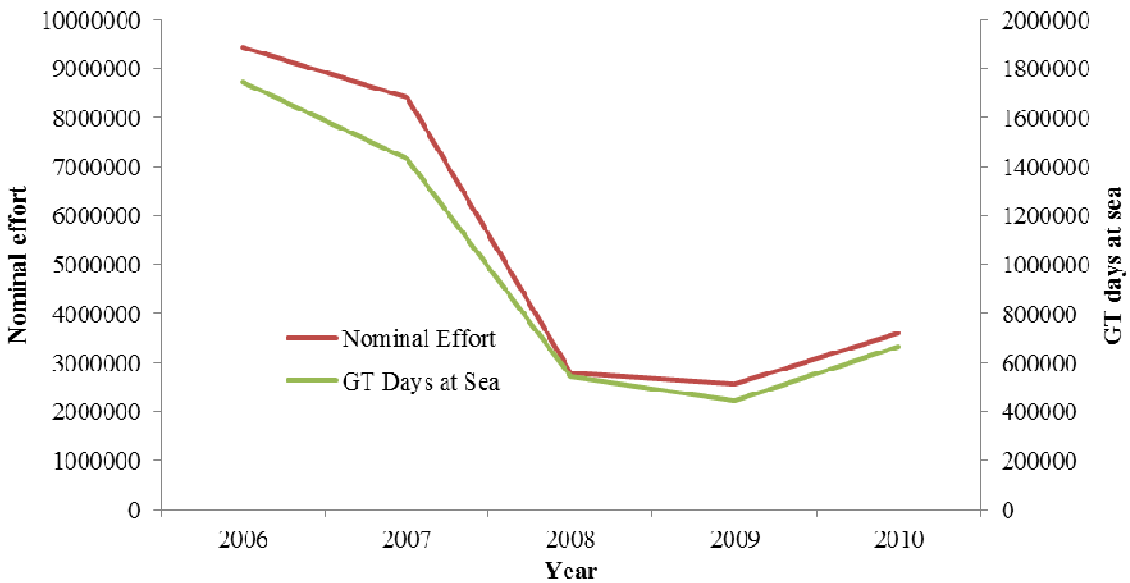


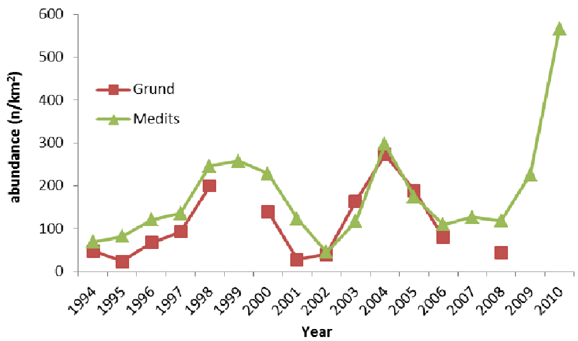
Fig. 6.11.2.4.1 Trends in annual fishing effort as nominal effort (kw*days) and GT*days at sea deployed in GSA09 from 2006 to 2010.

6.11.3 *Scientific surveys*

6.11.3.1 MEDITS

6.11.3.1.1 Methods

Since 1994 two trawl surveys are regularly carried out each year: MEDITS, in spring, and GRUND, in autumn. The two surveys gave a similar temporal trend in density and biomass of giant red shrimp and large fluctuations are present from year to year (Fig. 6.11.3.1.1.1).



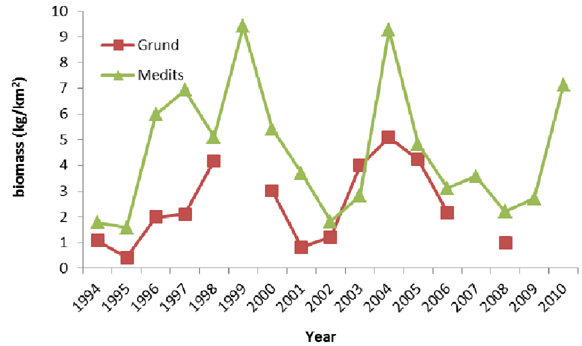


Fig. 6.11.3.1.1.1 *A. foliacea*: GRUND and MEDITS trends in density and biomass from 1994 to 2010 in GSA 09.

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA09 the following number of hauls was reported per depth stratum (Tab. 6.11.3.1.1.1).

Tab. 6.11.3.1.1.1. Number of hauls per year and depth stratum in GSA09, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA09_010-050	*21*	*20*	*20*	*20*	*21*	*20*	*20*	*19*	*15*	*14*	*15*	*16*	*15*	*15*	*16*	*16*	*15*
GSA09_050-100	*21*	*21*	*20*	*20*	*20*	*21*	*22*	*23*	*17*	*18*	*17*	*16*	*18*	*18*	*16*	*16*	*19*
GSA09_100-200	*38*	*40*	*40*	*40*	*39*	*39*	*38*	*38*	*30*	*30*	*30*	*31*	*29*	*30*	*31*	*31*	*29*
GSA09_200-500	*40*	*40*	*42*	*42*	*41*	*41*	*42*	*41*	*32*	*33*	*36*	*35*	*36*	*37*	*34*	*34*	*35*
GSA09_500-800	*33*	*32*	*31*	*31*	*32*	*32*	*31*	*32*	*26*	*25*	*22*	*22*	*22*	*20*	*23*	*23*	*22*
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$
$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$
Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.11.3.1.2 Geographical distribution patterns

The stock is more abundant in the southern part of the GSA (Tyrrhenian Sea) as showed in Figure 1.1.3.1.2.1 (from Ardizzone *et al*., Eds. CD-ROM Version)

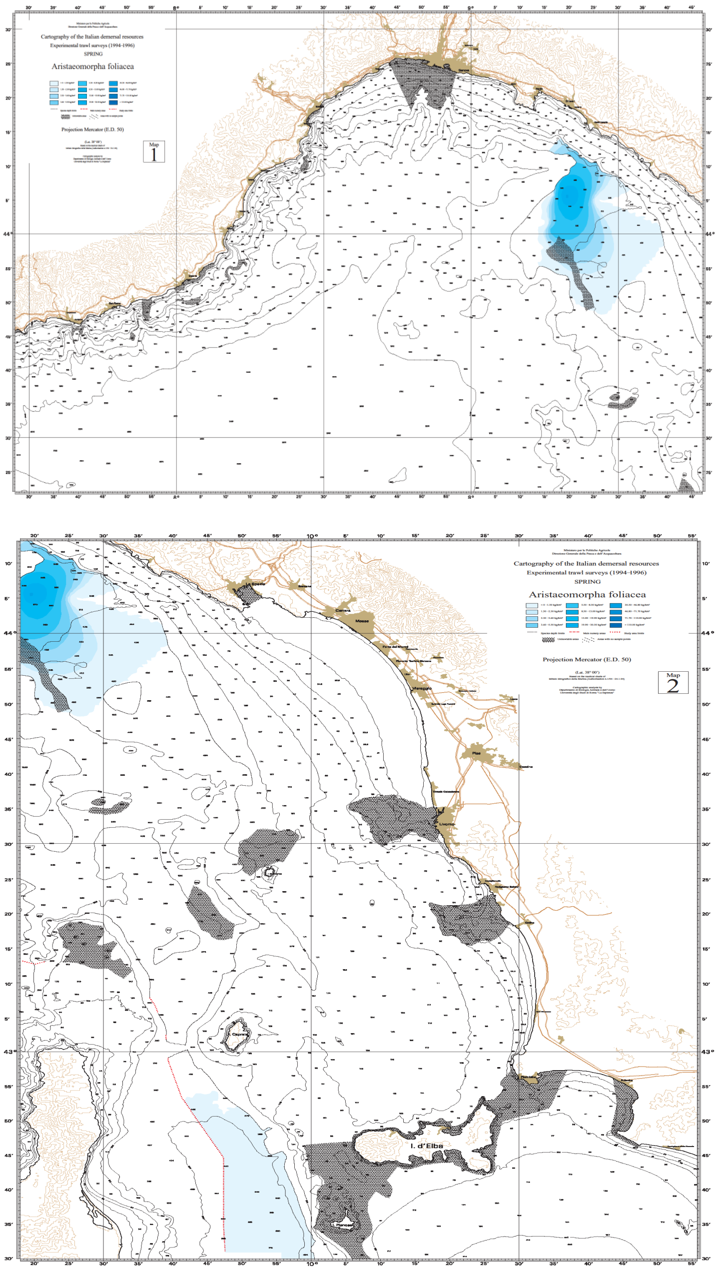


Fig. 6.11.3.1.2.1 *A. foliacea*: Biomass 1994-1996, GSA09 (Ligurian Sea).

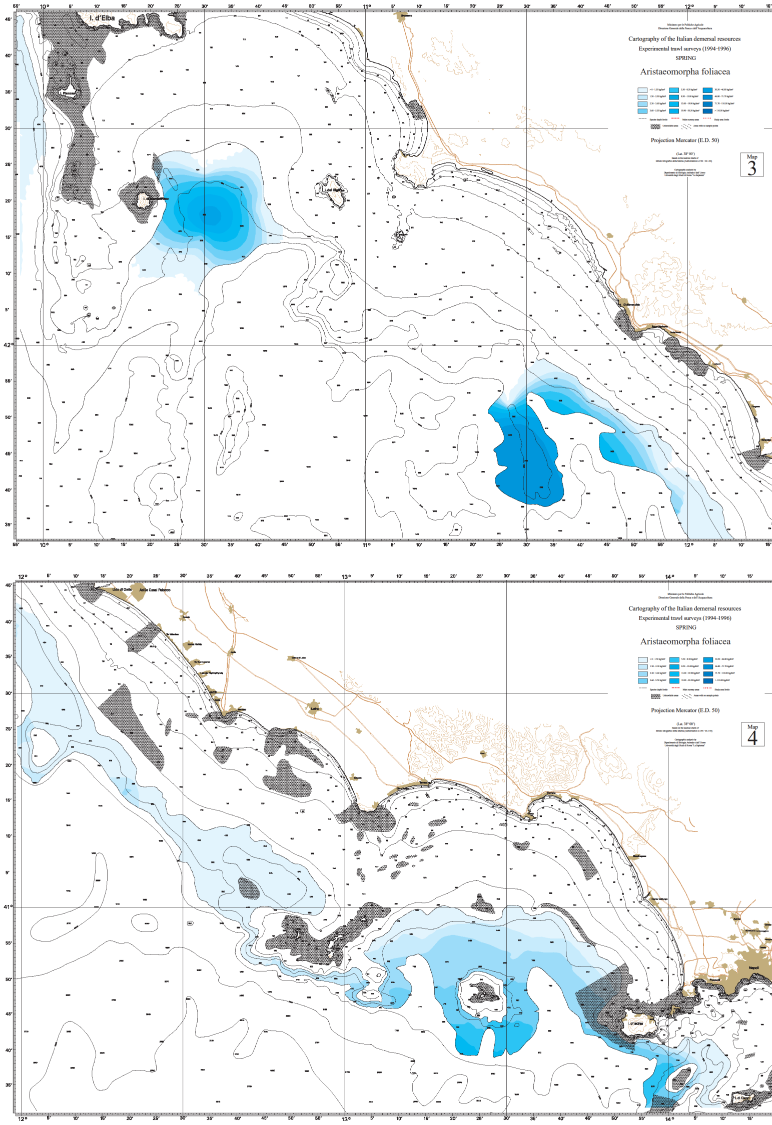


Fig. 6.11.3.1.2.2 *A. foliacea*: biomass 1994-1996, GSA09 (Northern and central Tyrrhenian Sea).

6.11.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp in GSA09 was derived from the international survey MEDITS. Figure 6.11.3.1.3.1 displays the estimated trend in *A. foliacea* abundance and biomass in GSA 09. The estimated abundance and biomass indices do not reveal a clear trend. In the period analyzed (2008-2010) indices showed a remarkable increase in 2010 both in terms of biomass and abundance indices.

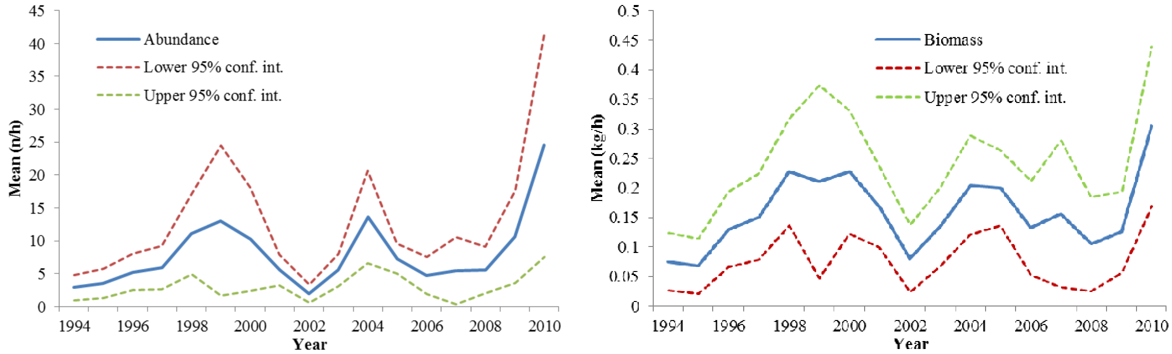


Fig. 6.11.3.1.3.1 Abundance and biomass indices of giant red shrimp in GSA09.

6.11.3.1.4 Trends in abundance by length or age

The following Fig. 6.11.3.1.4.1/3 display the stratified abundance indices of GSA 09 in 1994-2010.

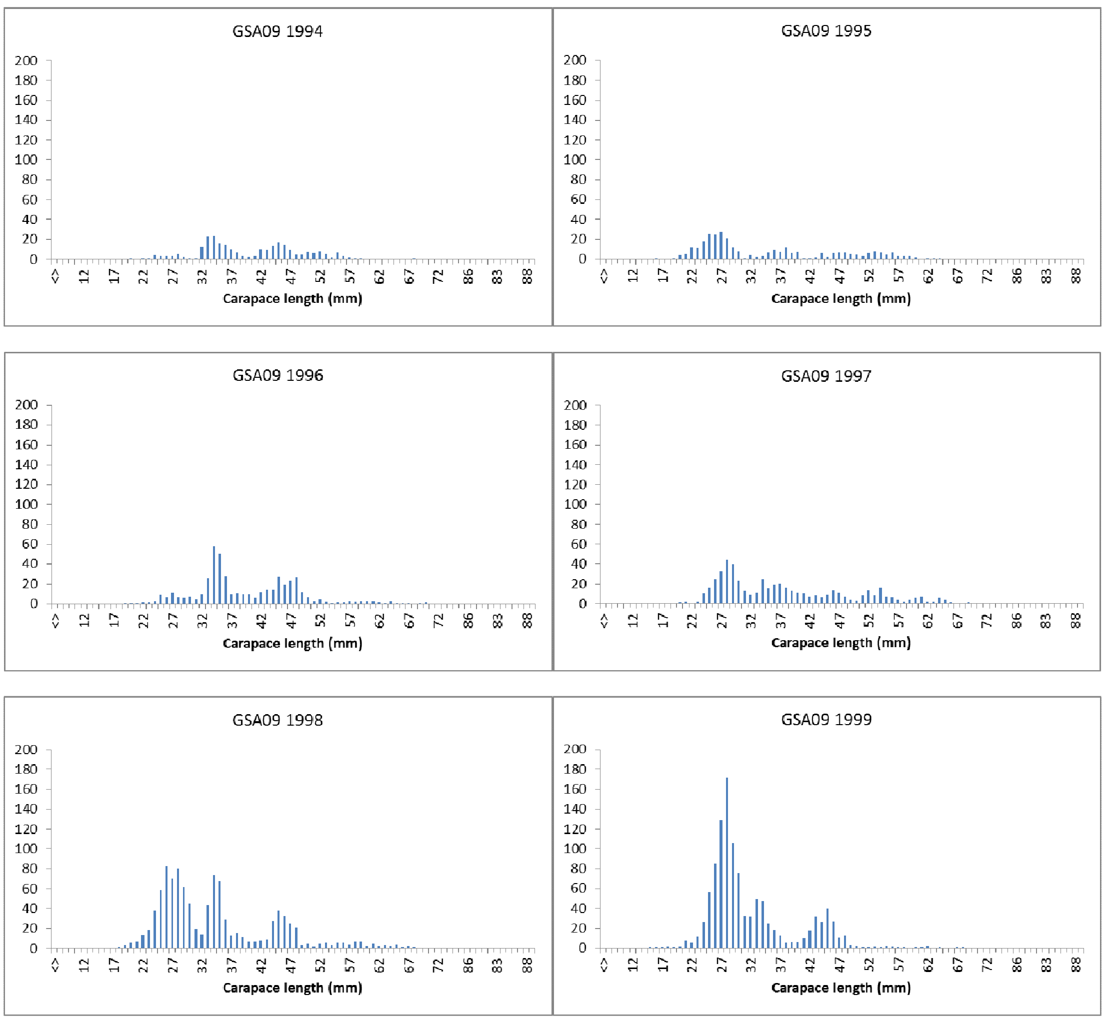


Fig. 6.11.3.1.4.1 Stratified abundance indices by size, 1994-1999.

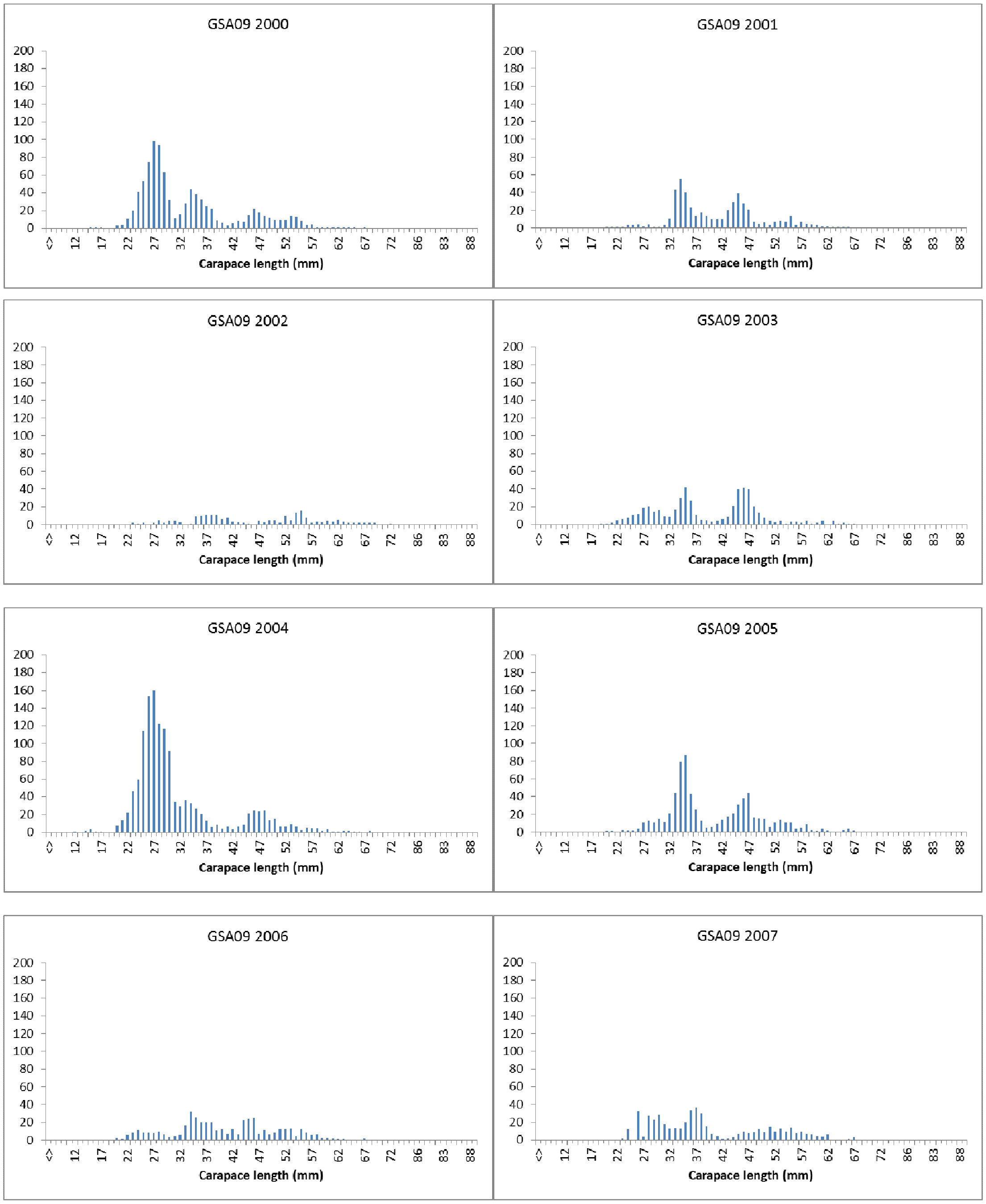


Fig. 6.11.3.1.4.2 Stratified abundance indices by size, 2000-2007.

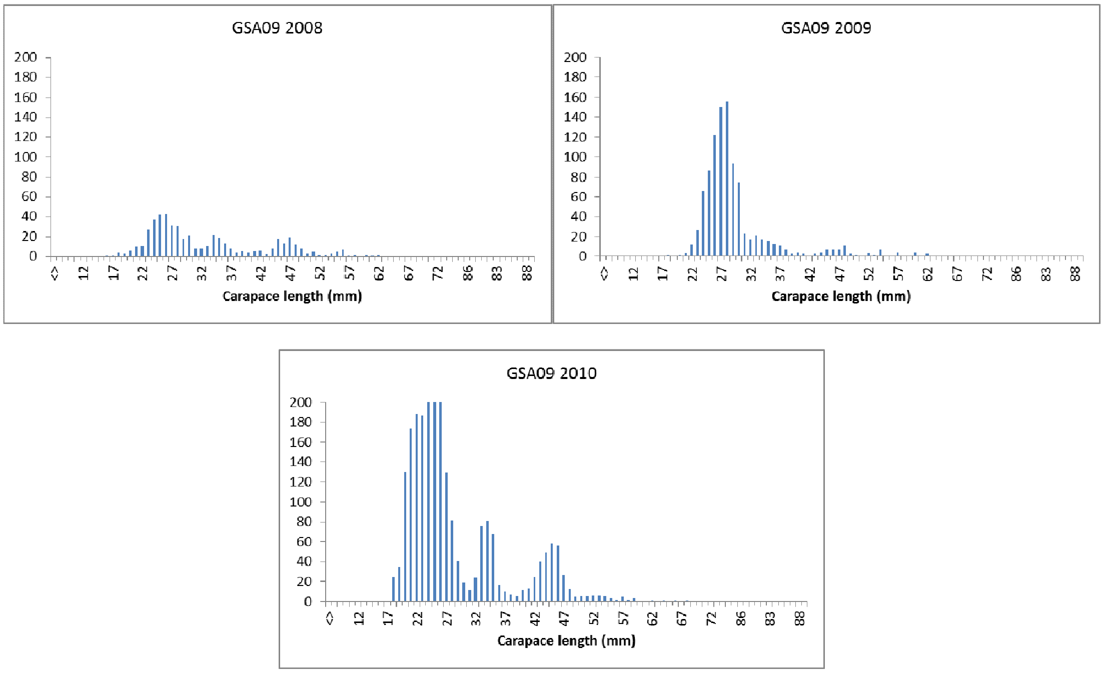


Fig. 6.11.3.1.4.3 Stratified abundance indices by size, 2008-2010.

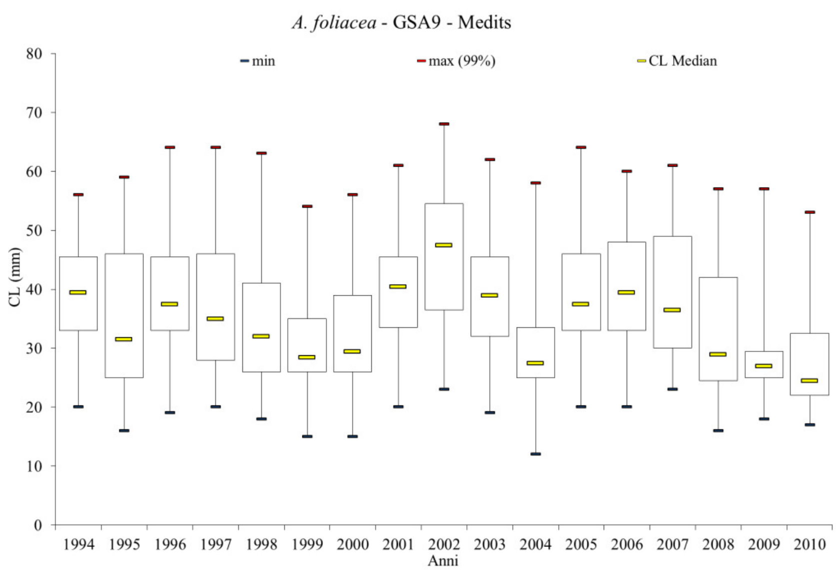


Fig. 6.11.3.1.4.4 Boxplot of the length frequency distributions obtained in the Medits surveys.

6.11.3.1.5 Trends in growth

No analyses were conducted during EWG 11-12.

6.11.3.1.6 Trends in maturity

No analyses were conducted during EWG 11-12.

6.11.4 Assessment of historic stock parameters

6.11.4.1 Method 1: LCA

6.11.4.1.1 Justification

The pseudo-cohort analysis VIT was applied using data from 2008 to 2010.

6.11.4.1.2 Input parameters

Data from DCF provided at EWG-11-12 contained information on giant red shrimp landings and the respective size structure for 2008-2010. A VPA was performed using a Length Cohort Analysis (LCA) and applying the routine included in the VIT package designed by Lleonart and Salat (1992) for each year separately. Biological parameters are listed in Tab. 6.11.4.1.2.1 and data used are reported in Tab. 6.11.4.1.2.2. A natural mortality vector computed by ProdBiom was used. Total length frequency was splitted by sex using a sex-ratio vector per length class (Fig. 6.11.4.1.2.1).

Tab. 6.11.4.1.2.1. Input data for LCA of giant red shrimp in GSA 09.

	Female	Male
Growth parameter	Linf=7.2, k=0.4, t0=0	Linf=4.27,k=0.77,t0=-0.27
LW	a=0.001 b=2.668	a=0.004 b=2.348
Natural mortality vector (Prodbiom)	age(0)=1.25 age(1)=0.73 age(2)=0.48 age(3)=0.39 age(4)=0.35 age(5)=0.32 age(6)=0.30 age(7)=0.29	age(0)=1.32 age(1)=0.77 age(2)=0.50 age(3)=0.41 age(4)=0.37 age(5)=0.34 age(6)=0.32 age(7)=0.31
Proportion of mature	age(0)=0.4 age(1)=0.8 age(2)=1 age(3)=1 age(4)=1 age(5)=1 age(6)=1 age(7)=1	age(0)=0.4 age(1)=0.8 age(2)=1 age(3)=1 age(4)=1 age(5)=1 age(6)=1 age(7)=1

Tab. 6.11.4.1.2.2. Input data for LCA Catch at length 2008-2010.

Carapace length (cm)	2008	2009	2010
2.0	0	1139	0
2.2	0	1139	19372
2.4	0	6829	117493
2.6	21548	29388	172723
2.8	110136	78892	285559
3.0	218358	82045	221963
3.2	179092	50414	172972
3.4	53848	73528	365796
3.6	38103	41003	227272
3.8	73208	46315	70512
4.0	76686	75974	30316
4.2	70254	99326	35843
4.4	60167	129350	120602
4.6	51664	107345	212947
4.8	41530	77268	191788
5.0	87923	88714	75567
5.2	50068	52084	49802
5.4	43532	43176	39856
5.6	39890	24158	37550
5.8	27493	15063	26093
6.0	22044	6330	9358
6.2	2922	3981	1922
6.4	0	3981	0
6.6	2394	663	1053
6.8	0	1327	0

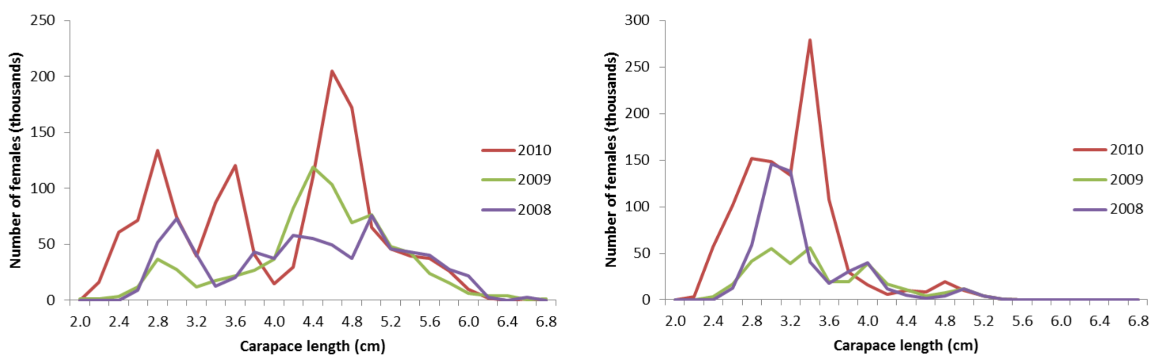


Fig. 6.11.4.1.2.1. Input data for LCA Catch at length by sex 2008-2010

6.11.4.1.3 Results

Giant red shrimp landings started at age class 1 and are mainly concentrated on age classes 1-5. (Fig. 6.11.4.1.3.1).

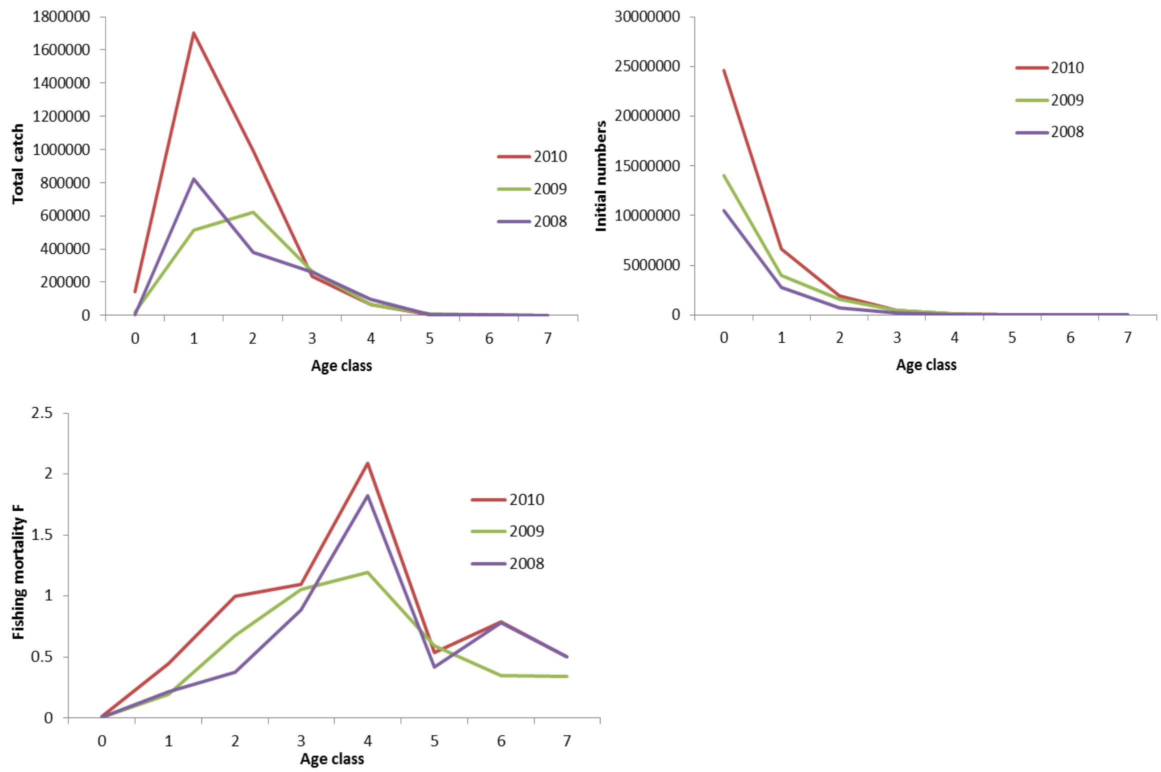


Fig.6.11.4.1.3.1 LCA outputs: catch numbers, numbers-at-age and fishing mortality at age of *A. foliacea* in the GSA09.

6.11.5 Long term prediction

6.11.5.1 Justification

The yield per recruit from the VIT was applied.

6.11.5.2 Input parameters

Length frequency data 2008 - 2010 by sex and biological parameters that were used as given in table 6.11.5.2.1.

Tab. 6.11.5.2.1. Input data for Y/R of giant red shrimp in GSA 09.

	Female	Male
Growth parameter	Linf=7.2, k=0.4, t0=0	Linf=4.27,k=0.77,t0=-0.27
LW	a=0.001 b=2.668	a=0.004 b=2.348
Natural mortality vector (Prodbiom)	age(0)=1.25 age(1)=0.73 age(2)=0.48 age(3)=0.39 age(4)=0.35 age(5)=0.32 age(6)=0.30 age(7)=0.29	age(0)=1.32 age(1)=0.77 age(2)=0.50 age(3)=0.41 age(4)=0.37 age(5)=0.34 age(6)=0.32 age(7)=0.31
Proportion of mature	age(0)=0.4 age(1)=0.8 age(2)=1 age(3)=1 age(4)=1 age(5)=1 age(6)=1 age(7)=1	age(0)=0.4 age(1)=0.8 age(2)=1 age(3)=1 age(4)=1 age(5)=1 age(6)=1 age(7)=1

	Female			Male		
Carapace length (cm)	2010	2009	2008	2010	2009	2008
2.0	0	1058	0	0	81	0
2.2	16216	953	0	3156	186	0
2.4	60408	3511	0	57085	3318	0
2.6	71170	12109	8879	101553	17279	12669
2.8	133844	36977	51622	151715	41915	58514
3.0	73943	27332	72742	148020	54713	145616
3.2	39347	11468	40739	133625	38946	138353
3.4	86855	17459	12786	278941	56069	41062
3.6	119968	21644	20113	107304	19359	17990
3.8	41173	27044	42747	29339	19271	30461
4.0	14639	36686	37029	15677	39288	39657
4.2	29588	81993	57994	6255	17333	12260
4.4	110616	118640	55185	9986	10710	4982
4.6	204906	103292	49713	8041	4053	1951
4.8	172222	69385	37293	19566	7883	4237
5.0	65183	76524	75841	10384	12190	12082
5.2	45752	47849	45996	4050	4235	4072
5.4	39248	42517	42867	608	659	665
5.6	37550	24158	39890	0	0	0
5.8	26093	15063	27493	0	0	0
6.0	9358	6330	22044	0	0	0
6.2	1922	3981	2922	0	0	0
6.4	0	3981	0	0	0	0
6.6	1053	663	2394	0	0	0
6.8	0	1327	0	0	0	0

6.11.5.3 Results

The resulting Y/R and SSB/R are illustrated in the following figures. All ages reference point $F_{0.1}$=0.50 while in table 6.11.5.3.1 are reported the main result of the LCA analysis

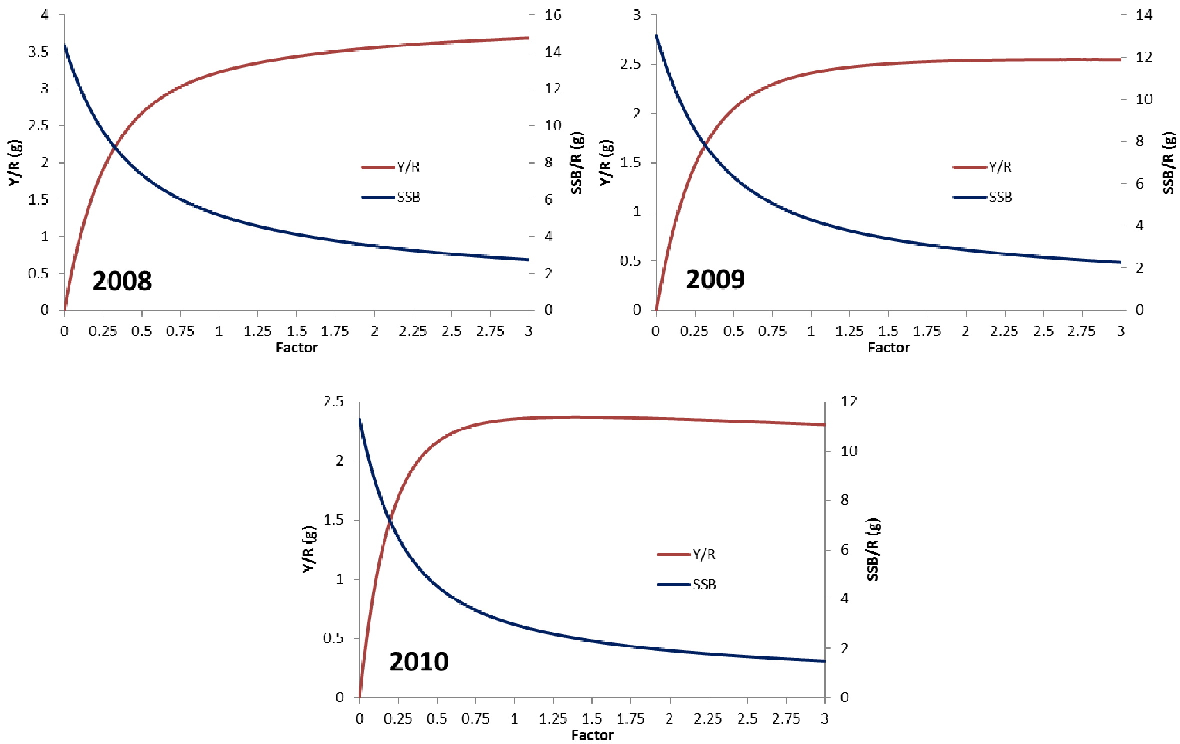


Fig. 6.11.5.3.1 LCA outputs: Yield per recruit per recruit and Spawning stock Biomass per recruits curves of *A. foliacea* in the GSA09.

Table 6.11.5.3.1 LCA outputs.

		Factor	Absolute F	Y/R	B/R	SSB
2008	Virgin	0.00	0.00	0.00	17.88	14.86
	$F_{0.1}$	0.74	**0.55**	3.07	9.20	6.39
	F_c	1.01	0.75	3.31	8.07	5.33
	F_{max}	3.00	2.23	3.78	5.19	2.85
2009	Virgin	0.00	0.00	0.00	16.00	15.00
	$F_{0.1}$	0.65	**0.48**	2.39	7.01	6.05
	F_c	1.01	0.75	2.56	5.42	4.47
	F_{max}	1.69	1.25	2.68	4.50	3.60
2010	Virgin	0.00	0.00	0.00	13.17	12.15
	$F_{0.1}$	0.45	**0.47**	2.14	6.14	5.17
	F_c	1.01	1.05	2.34	4.00	3.08
	F_{max}	1.55	1.60	2.40	3.84	2.98
	Mean	***$F_{0.1}$***	***0.50***			
		F_c	***0.85***			
		F_{max}	***1.69***			

6.11.6 Data quality

Medits survey data were available from 1994 to 2010 and since high differences in abundance and biomass per hour indexes was recognized between EWG 11-05 and EWG 11-12, the data need to be checked.

6.11.7 Scientific advice

6.11.7.1 Short term considerations

6.11.7.1.1 State of the stock size

Stock assessment has been computed by Length Cohort Analysis (VIT software) using DCF data of landings at age (2008-2010). Results obtained did not show a clear trend in the stock size. Medits survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. However, indices of biomass and abundance showed a remarkable increase in 2010. Since no precautionary level for the stock of giant red shrimp in GSA09 was proposed, EWG 11-12 is unable to fully evaluate the stock status in relation to the precautionary approach.

6.11.7.1.2 State of recruitment

2010 Medits indices indicate a high recruitment impulse.

6.11.7.1.3 State of exploitation

EWG 11-12 proposes $F_{0.1} \leq 0.50$ as limit management reference point consistent with high long term yields (F_{MSY} proxy).

According to the F estimates obtained using Length Cohort Analysis, the estimated F in 2010 amounts to F=1.05. STECF EWG 11-12 classifies the stock as being subject to overfishing. EWG 11-12 recommends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

It is important to consider that this stock could be strongly affected by environmental and ecological factors (e.g. water temperature, predation) which may alter the conclusion regarding its exploitation status.

6.12 Stock assessment of spottail mantis shrimp in GSA 09

6.12.1 Stock identification and biological features

6.12.1.1 Stock Identification

The spottail mantis shrimp, *Squilla mantis*, is found in Mediterranean waters and in the adjacent Atlantic, where it has been reported from the Gulf of Cadiz and from the Canary Islands and Madeira, its southernmost distribution being Angola.

It is a demersal species distributed on sandy and muddy bottoms of the continental shelf, from 3 m to around 150 m depth, and occasionally at deeper depth (350 m). Mantis shrimp is present in high densities in areas with suitable burrowing substrates (fine sand and sandy mud), especially where the influence of river run-off is important. It is a strongly sedentary species and the seasonal trends appearing in catch data series are not so much due to temporal changes in its distribution (limited migratory habits), as to its reproductive and burrowing behaviour, as linked to recruitment patterns.

The mating season occurs from winter to spring (January to June), when females have their cement glands active, although the activity of these glands may start as early as October. Eggs are shed from April to June. In spring and early summer, females incubate the eggs in their burrows. During incubation, females do not leave their burrows. In the eastern Ligurian Sea (GSA 09), females with mature gonads were found from January to June, with a clear peak in April; this trend was also confirmed by the monthly development of the maturity stages (and further confirmed by the gonadosomatic index), that reached maximum values in March-April.

Due to a lack of information about the stock identification of mantis shrimp population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries. As a matter of fact, there is not any available definition of unit stocks neither based on genetics, bio-chemistry, fishery-based nor on any alternative method based on somatic features. Under a management point of view, in the frame of GFCM, it has been decided, when the lack of any evidence does not allow suggesting an alternative hypothesis, that inside each one of the GSAs boundaries inhabits a single, homogeneous mantis shrimp stock that behaves as a single well-mixed and self-perpetuating population.

The hypothesis of a single stock of mantis shrimp in GSA9, which includes waters belonging to 2 seas (Ligurian and Tyrrhenian) separated by the Elba Island and fleets that do not show any spatial overlapping is almost unlikely.

6.12.1.2 Growth

The growth has not been recently studied in GSA 09. In the past studies carried out on a limited part of the area showed that the maximum sizes caught (37-40 mm CL) in the fishery would correspond to 3-year old individuals. For the analyses a combination of the following set of parameters estimated for the Adriatic Sea have been adopted: L_∞ = 41.2, K=0.53 for males and L_∞ = 41.9, K=0.45 for females. The life cycle is of about 5 years. The growth rates by age seem to be quite similar between the two sexes.

6.12.1.3 Maturity

Size at maturity for females is 20-24 mm CL, when considering maturity by the development of the cement glands; female *Squilla mantis* mature within 1 year of settlement to the bottom and spawn within their second year of life.

6.12.2 Fisheries

6.12.2.1 General description of fisheries

Although in GSA 09 the species is exploited by different types of gears, the majority of the landing comes from bottom trawling. The annual landing for 2009 was due for 95% to bottom trawl (381 tons), for 2.25% to Gillnet (9 tons) and for 2.25% to trammel net (9 tons).

In 2010 trawl landing (372 tons) represented 96.4% of the total landing, while gillnet and trammel net contributed for 3.1% and 0.5% respectively.
About 200 bottom trawlers exploit this resources all year round in the coastal area. Mantis shrimp is caught as a part of a species mix that constitutes the target of the trawlers operating on the continental shelf near shore. The main species caught in GSA 09 associated with mantis shrimp are *Sepia officinalis, Trigla lucerna, Merluccius merluccius, Mullus barbatus, Octopus vulgaris.* Trawl catch is mainly composed by age 1 and 2 individuals while the older age classes are poorly represented in the catch. As concerns artisanal fisheries, *S. mantis* is a by catch of by gillnet and trammel net targeting other species in the coastal area.

The burrowing behaviour of *Squilla mantis* makes it vulnerable only when individuals are out of their burrows and this occurs mainly at night, between sunset and sunrise. Seasonal variations in catchability result from reduced out-of-burrow activity, because females rarely exit their burrow when they are incubating their egg mass in spring and early summer. Conversely, catches are much increased in winter, when mating takes place. Catches are further increased in late autumn with the incorporation of new recruits. The reproductive behaviour the species also influences the relative proportion of males and females in the catches by season: females outnumber males only in winter (mating season), while the sex-ratio is biased towards males in spring and summer. Additionally, weather and sea conditions represent an important influence on the catchability of this species as catches increase after prolonged bad weather conditions probably because of disturbance of the burrow systems as a result of the high turbidity.

6.12.2.2 Management regulations applicable in 2010 and 2011

- Minimum landing sizes: None.
- Fishing closure for trawling: 30-45 days in late summer (not every year have been enforced).
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets have been replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast. However, towed gears are always forbidden inside 1.5 miles from the coast with the exception of some areas of the Ligurian Sea that have benefited from the derogation according by the EC Regulation 1967/2006 for the Mediterranean Sea.
- Two small No Take Zones (“Zone di Tutela Biologica”, ZTB) are present inside the GSA 09; one off the Giglio Island (50 km^2, northern Tyrrhenian Sea) another off Gaeta, (125 km^2, central Tyrrhenian Sea). Bottom fishing was not allowed in the two ZTB. A recent regulation of the Italian Ministry of Agricultural, Food and Forestry Policies has established that fishing activity can be carried out in these two areas from July 1st to December 31st.

6.12.2.3 Catches

6.12.2.3.1 Landings

The total landing showed a decreasing trend in the period 2004-2010 (Fig. 6.12.2.3.1.1 and Tab. 6.12.2.3.1.1), with maximum value in 2005 (590 tons) and minimum in 2010 (386 tons). The species is mainly landed by the trawl fleet (OTB) fishing on the continental shelf. A fluctuating trend in the landing of OTB is observed, with lower values in the last three years. This tendency seems to be mainly due to the reduction in fishing effort observed for this type of gear, while the LPUE remained quite constant during the period analysed (6.12.2.3.1.2). The decreasing trend in the landing is more evident for artisanal gears. In 2009 the landing of gillnet (GNS) and trammel net (GTR) was 18 tons, representing only the 4.5% of the total landing of the species, while in 2010 the contribution of these two gears was 3.6%. The LPUEs for gillnet and trammel net show a significant reduction, particularly evident in the case of the previous one.

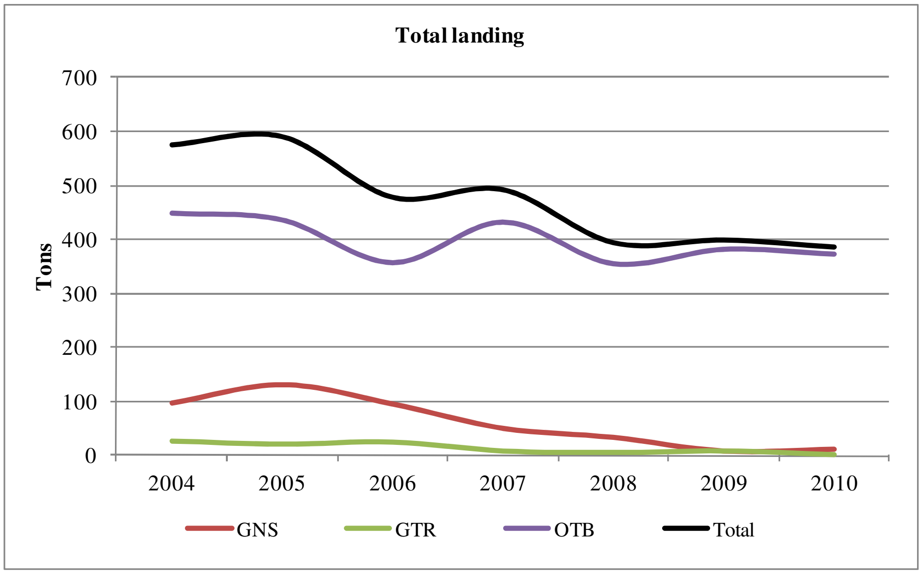


Fig. 6.12.2.3.1.1 Landings (in tons) from the trawl and small-scale fleets in the GSA 09 in the period 2004-2010 (official 2011 DCF data call). GNS: gillnets; GTR: trammel net; OTB: demersal trawling.

Tab. 6.12.2.3.1.1 Landings and discard (in tons) of mantis shrimp as reported through the official 2011 DCF data call.

	2004	2005	2006	2007	2008	2009	2010
Otter trawl	449	436	356	432	354	381	372
Gillnet	98	132	96	51	34	9	12
Trammel net	28	22	26	9	6	9	2
Total	575	590	478	492	394	399	386
Discard						86	49

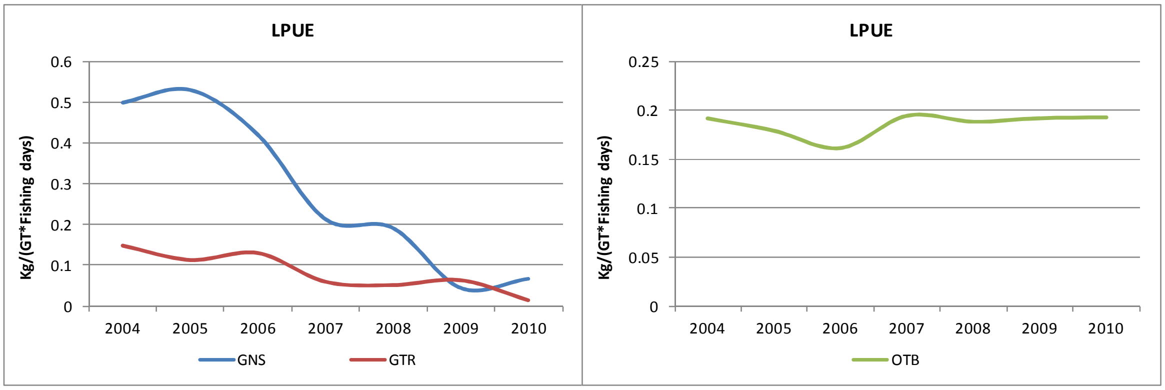


Fig. 6.12.2.3.1.2 Landing per Unit of Effort (LPUE) for set nets (left) and trawling (right) in the GSA 09 for the period 2004-2010 (official 2011 DCF data call). GNS: gillnets; GTR: trammel net; OTB: demersal trawling.

6.12.2.3.2 Discards

According to the data collected in 2009 and 2010 in the framework of DCF, trawl discard represented 18.4 and 11.6% respectively of the total catches. This fraction is composed by not marketable specimens (small size or damaged individuals). No information is available about the discard of set nets.

6.12.2.4 Fishing effort

The fishing capacity of the GSA 09 has shown in these last 10 years a progressive decrease. Fishing effort (GT*fishing days) performed by the GSA 09 trawlers fishing for demersal species decreased from about 2,342,000 in 2004 to about 1,929,000 in 2010. A decreasing trend has been detected also for trammel net, from 190,000 in 2004 to 143,000 in 2009, while gillnet showed a slightly increase from 197,000 in 2004 to 210,000 in 2009 (Fig. 6.12.2.4.1).

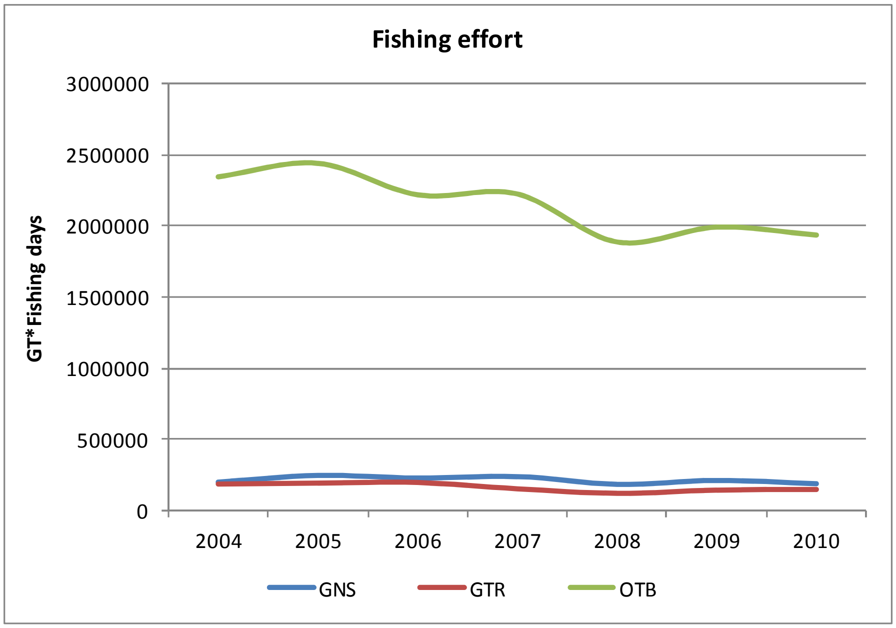


Fig. 6.12.2.4.1 Fishing effort (GT* fishing days) for the different type of gears in the GSA 09 during 2004-2010 period.

6.12.3 Scientific surveys

6.12.3.1 MEDITS

6.12.3.1.1 Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls was reported per depth stratum (Tab. 6.12.3.1.1.1).

Tab. 6.12.3.1.1.1. Number of hauls per year and depth stratum in GSA09, 1994-2010.

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA09_010-050	21	20	20	20	21	20	20	19	15	14	15	16	15	15	16	16	15
GSA09_050-100	21	21	20	20	20	21	22	23	17	18	17	16	18	18	16	16	19
GSA09_100-200	38	40	40	40	39	39	38	38	30	30	30	31	29	30	31	31	29
GSA09_200-500	40	40	42	42	41	41	42	41	32	33	36	35	36	37	34	34	35
GSA09_500-800	33	32	31	31	32	32	31	32	26	25	22	22	22	20	23	23	22
Total	153	153	153	153	153	153	153	153	120	120	120	120	120	120	120	120	120

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi^*Ai) / A$$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$
Where:
A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean
The variation of the stratified mean is then expressed as the 95 % confidence interval:
Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.12.3.1.2 Geographical distribution patterns

No information was documented during EWG 11-12.

6.12.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the spottail mantis shrimp in GSA09 was derived from the international survey MEDITS. Figure 6.12.3.1.3.1 displays the estimated trend in abundance and biomass. The estimated abundance and biomass indices do not reveal a clear trend.

Although mantis shrimp is not a target species in the Medits survey, data collected allowed to estimate the density of the population. In Fig. 6.12.3.1.3.1 the trends of the number of specimens and biomass indices estimated for the depth stratum 0-200 m are reported. The two trends, very similar to each other, show a very high peak in 1996 and minimum values in the period 1997-2001. The last years are characterised by a stable trend in number and a slightly increase in weight.

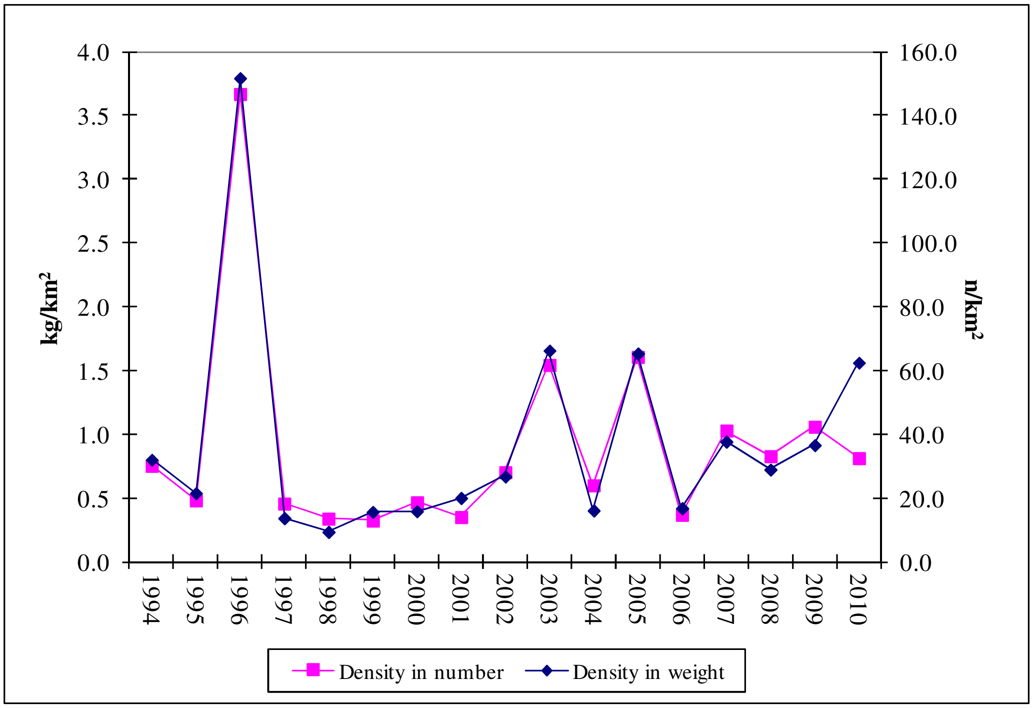


Fig. 6.12.3.1.3.1 Trends of the number of specimens and biomass indices estimated for the depth stratum 0-200 m are reported.

6.12.3.1.4 Trends in abundance by length or age

No information was been documented.

6.12.3.1.5 Trends in growth

No information was been documented.

6.12.3.1.6 Trends in maturity

No information was been documented.

6.12.4 Assessments of historic stock parameters

6.12.4.1 Method 1: LCA

6.12.4.1.1 Justification

During the EWG-11-05 the first assessment of mantis shrimp in the GSA 09 was performed on 2009 data. In EWG-11-12 the analyses were carried out on 2010 data applying the same methodology.

A LCA was performed aimed at the estimation of a vector of *F* at size, using data on total annual catches by size. Data used in the analysis cover set nets (trammel net + gillnet) and trawling (including discard). The analyses were performed for two years separately (2009 and 2010). Considering that only data for two years were available, it was not possible to perform a formal VPA. The software used to carry out the analyses was VIT.

6.12.4.1.2 Input parameters

Data, derived from commercial catches (landing and discard) by size/age for sexes combined were used to estimate F, the value of the $F_{0.1}$, the numbers at age and other features.

The length frequency distribution and the age frequency distribution landing are shown in Fig. 6.12.4.1.2.1 and 2, respectively.

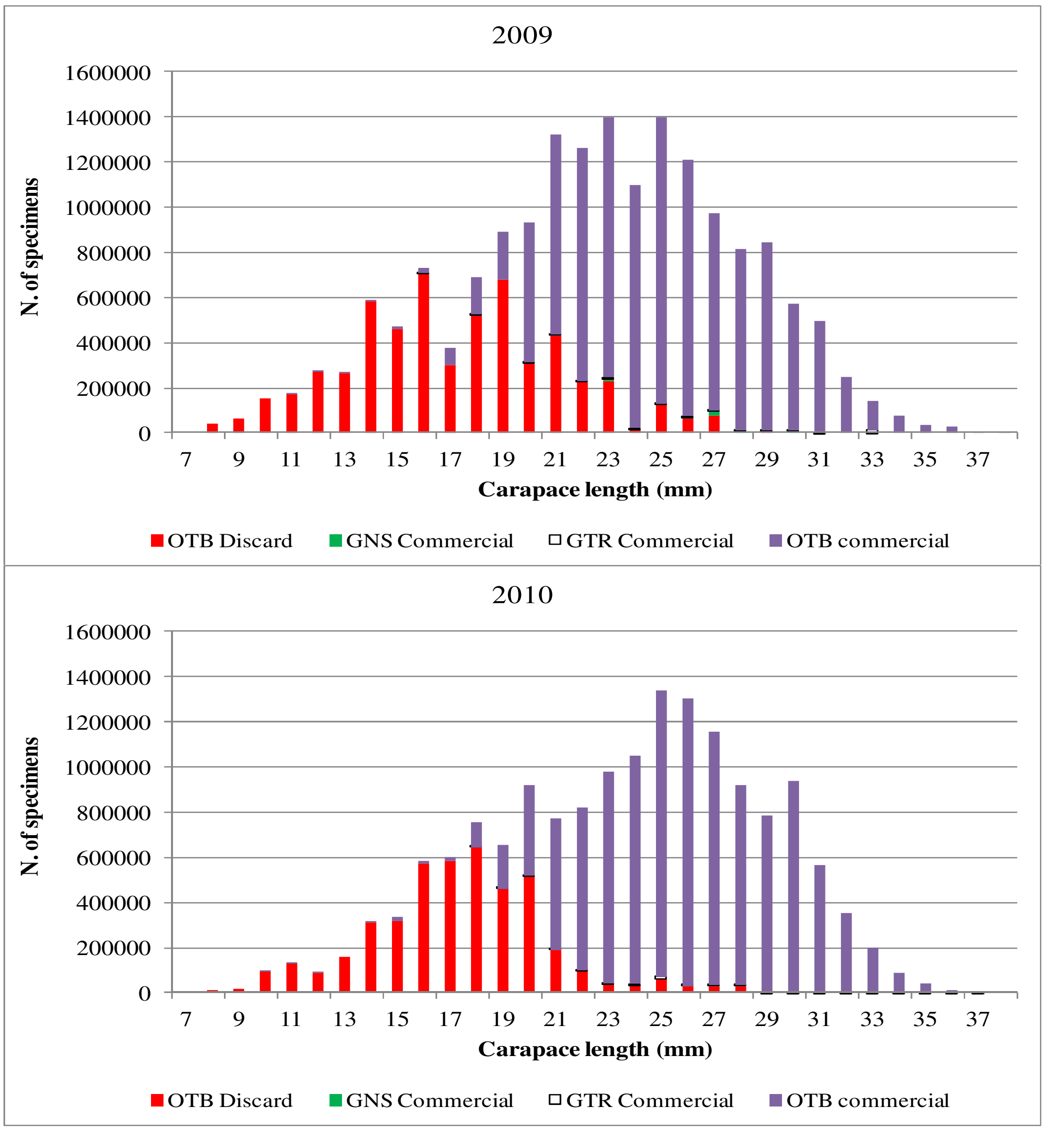


Fig. 6.12.4.1.2.1 Size frequency distributions of trawl fleet (OTB), gillnet (GNS) and trammel net (GTR) for 2009 (above) and 2010 (below).

The exploited size range is comprised between 8 and 37 mm carapace length (CL), corresponding to specimens between 0+ and 5 age classes. The discarded specimens show a size range between 8 and 29 mm CL, the majority of them with a size comprised between 12 and 21 mm CL (0+ and 1 age classes). The trawl landing is composed by specimens between 14 and 38 mm CL, with higher abundances of the size classes comprised between 20 and 31 cm CL (1 and 2 age classes). The total catches (commercial + discarded fractions) was mainly composed by 1 and 2 age classes.

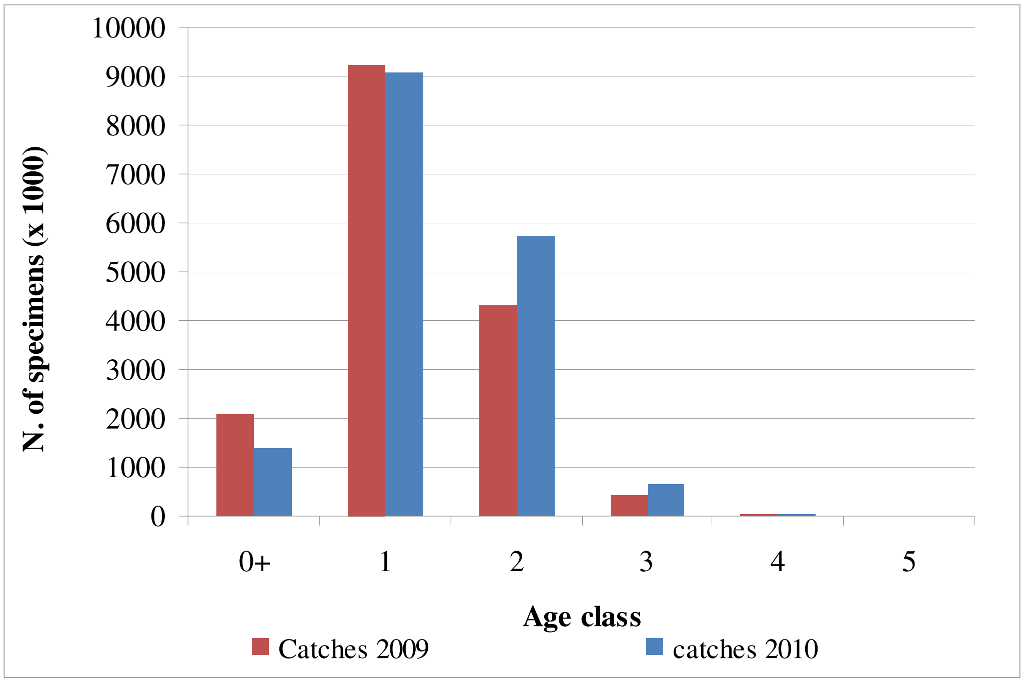


Fig. 6.12.4.1.2.2 Numbers at age of the total catches for 2009 and 2010.

Tab. 6.12.4.1.2.1 Numbers at age (in thousands) of the total catches for 2009 and 2010.

	Year	
Age class	2009	2010
0+	2070	1389
1	9239	9084
2	4235	5740
3	390	663
4	38	32
5	6	5
Total	15978	16920

Tab. 6.12.4.1.2.2 Biological input parameters.

The following set of parameters was used to perform the LCA:

Growth parameters (Von Bertalanffy)
$L\infty$ = 41.0 (mm, carapace length)
K = 0.5
to =
L*W
a = 0.099
b = 1.737
Natural mortality
M vector Age_1=1.42 , Age_2=0.63, Age_3=0.48, Age_4=0.41, Age_5=0.37, Age_6=0.36
Length at maturity (L_{50})
L_{50} = 20.0 mm CL
Proportion of matures
Age_1=0.04, Age_2=0.90, Age_3=1.00, Age_4=1.00, Age_5=1.00, Age_6=1.00

The vector of natural mortality M was estimated using the software Prodbiom.

6.12.4.1.3 Results

VIT results regarding the pattern of catch in biomass reconstruction by age, the initial number by age and the total and by gear fishing mortality by age are showed in Fig. 6.12.4.1.3.1 The total catch in biomass is almost due to the fish of 1 and 2 age classes. Fishing mortality significantly affects the stock from 1 age class onward, with highest values on 2 and 3 age class individuals.

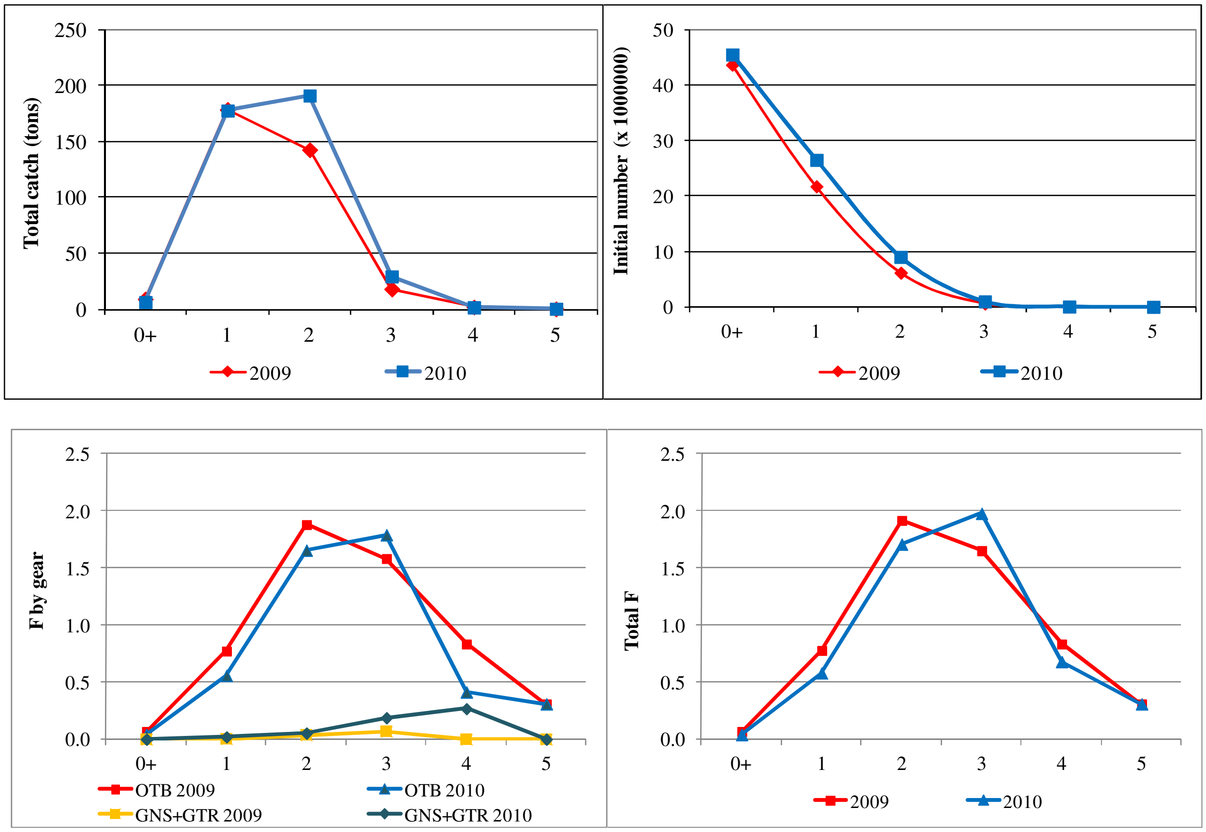


Fig. 6.12.4.1.3.1 CA outputs: catch in biomass, initial number and fishing mortality at age (by gear and total) of *Squilla mantis* in the GSA 09.

6.12.5 Long term prediction

6.12.5.1 Justification

Yield per recruit analysis was conducted based on the exploitation pattern resulting from the VIT model and population parameters.

The Y/R analysis allowed to estimate the relative yields and surviving fraction of the parental biomass and to produce an estimate of $F_{0.1}$ which can be considered a proxy of F_{MSY}.

6.12.5.2 Input parameters

Input parameters were those used in the VIT assessment described above.

6.12.5.3 Results

Fig. 6.12.5.3.1 shows the results of the yield per recruit analysis and the Y/R and SSB/R.

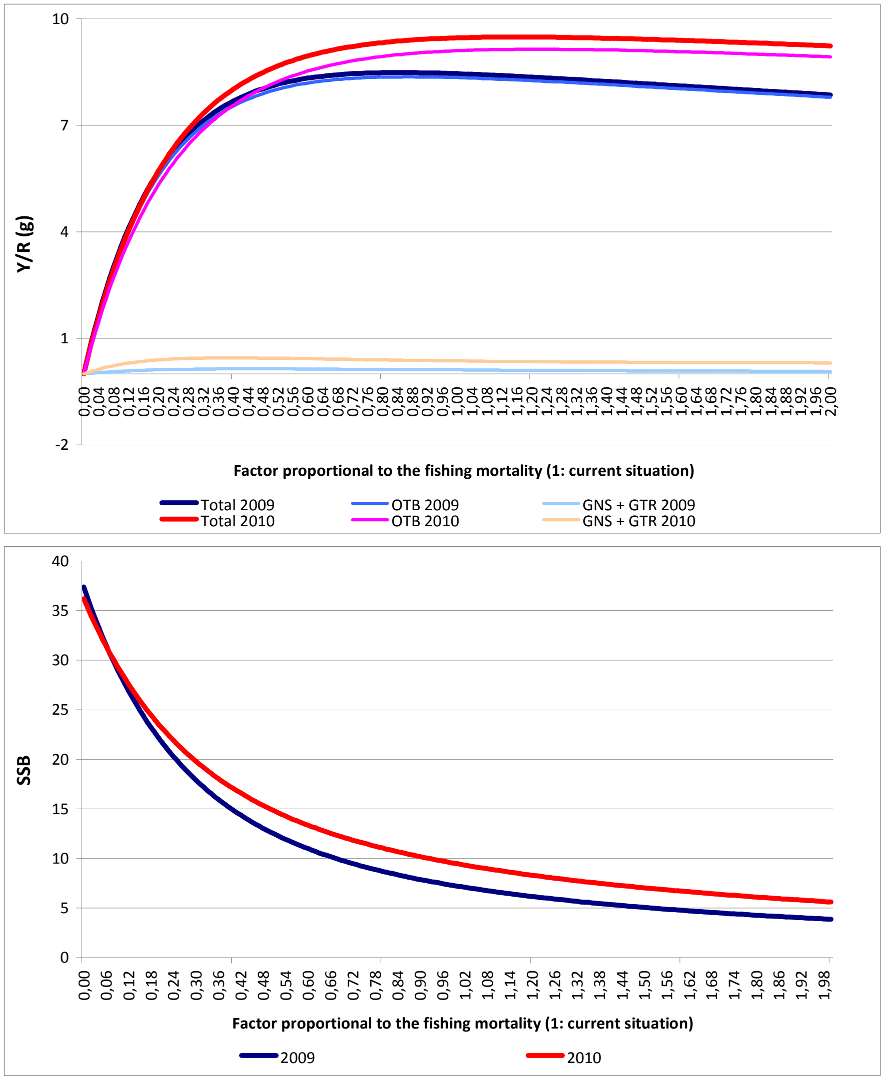


Fig. 6.12.5.3.1 Results of the Y/R analysis.

Tab. 6.12.5.3.1 and Fig. 6.12.5.3.2 show the current fishing mortality (F_{curr}), along with the reference points $F_{0.1}$ and the F_{max}.

The F current is the mean of the F values obtained from the LCA analysis for the 1-4 age classes excluding the first (0+) and the last (5+) age class.

Tab. 6.12.5.3.1 Results summarising the yield per recruit analysis performed on 2009 and 2010 data.

		Factor	Absolute F	Y/R	B/R	SSB
2009	Virgin	0,0	0,0	0,00	41,4	37,4
	$F_{0.1}$	0,5	0,6	7,9	17,5	13,7
	F Current	1,0	1,3	8,5	10,8	7,2
	F_{max}	0,9	1,1	8,5	11,8	8,2
2010	Virgin	0,0	0,0	0,0	40,7	36,2
	$F_{0.1}$	0,4	0,5	7,9	21,6	17,3
	F Current	1,0	1,2	9,4	13,6	9,5
	F_{max}	0,9	1,1	9,5	12,7	8,6

Mean	$F_{0.1}$	0,5
	F Current	1,3
	F_{max}	1,1

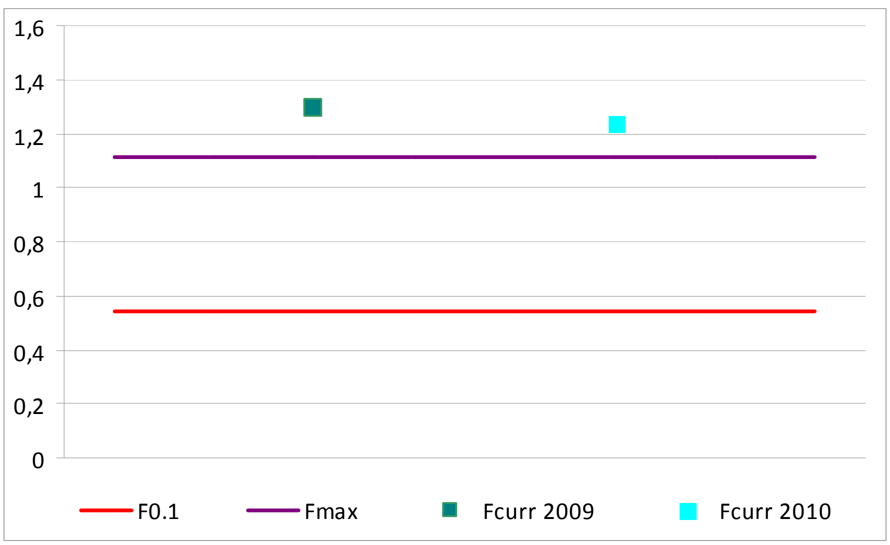


Fig. 6.12.5.3.2 Current fishing mortality and the referent points $F_{0.1}$ and F_{max}.

6.12.6 Data quality

No specific comments were raised.

6.12.7 Scientific advice

6.12.7.1 Short term considerations

6.12.7.1.1 State of the stock size

EWG 11-12 is unable to fully evaluate the status of the stock size as no precautionary reference point is defined. The analyses performed give a SSB estimation of 368 tons in 2009 and 430 tons in 2010. The Medits survey indicate recent fluctuations without a clear trend in stock abundance.

6.12.7.1.2 State of recruitment

Given the quality of data and results, EWG 11-12 cannot conclude on the state of recruitment. The analyses performed give an estimation of $43x10^6$ and $45x10^6$ recruits in 2009 and 2010 respectively.

6.12.7.1.3 State of exploitation

EWG-11-12 proposes $F_{0.1} \leq 0.54$ as limit management reference point consistent with high long term yields (F_{MSY} proxy).

The current F=1.30 and 1.24 estimated for 2009 and 2010 respectively are above the Y/R $F_{0.1}$ reference point (0.54), which indicates that mantis shrimp in GSA 09 is subject to overexploitation.

EWG 11-12 recommends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings. This can be done by reducing fishing effort of the relevant fleets taking into account mixed-fisheries effects. Catch forecasts consistent with the adopted measures shall be estimated.

EWG-11-12 emphasizes that this is the first attempt to evaluate the exploitation state of the species and, therefore, it is necessary to analyse a longer data series in order to confirm the results obtained for 2009 and 2010.

6.13 Stock assessment of Norway lobster in GSA 09

6.13.1 Stock identification and biological features

6.13.1.1 Stock Identification

Due to a lack of information about the structure of Norway lobster (*Nephrops norwegicus*) population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries. Adults tend to be territorial, with limited migration. However, transferal of larvae between areas may occur.

N. norvegicus is a mud-burrowing species that prefers sediments with mud mixed with silt and clay in variable proportions. The emergence from burrows of individuals may vary depending on biological features or environmental factors (moult or reproduction cycles, light intensity, etc).

The species lives on muddy substrates at depths between 150 and 800 m, but in the area is more commonly found between 250 and 800 m depth (Biagi *et al*., 2002; Colloca *et al.*, 2003).

Recruits peak in abundance between 400 and 500 m depth over the upper slope and appear to move slightly deeper when they reach 30 mm carapace length (Fig. 6.13.1.1.1).

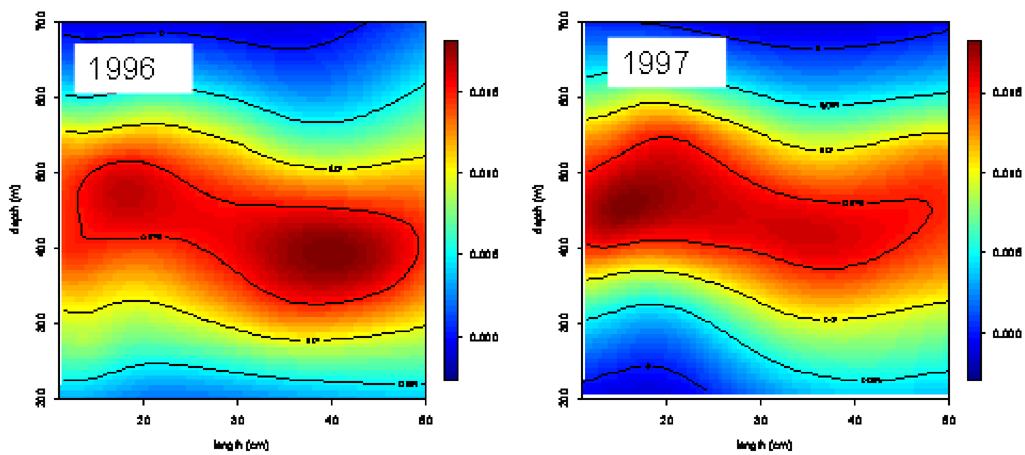


Fig. 6.13.1.1.1 Size-depth distribution of Norway lobster in the GSA 09 in 1996 and 1997 (GRUND survey).

6.13.1.2 Growth

The species shows a noticeable sexual dimorphism, with males that reach bigger sizes than females. Maximum observed size in the GSA 09 was 72 mm CL for males and 57 mm CL for females.
Growth parameters defined in the area were:

L_∞ =72.1 (males) 56 (females)

K = 0.169 (males) 0.214 (females)

Length-weight relationship for both sexes: a = 0.00040, b = 3.126

6.13.1.3 Maturity

Males reach maturity at 40 mm CL and females at 30.3 mm CL. Sex ratio is about 1:1 until 26 mm CL; in favour of females from 26 to 35 mm CL; in favour of males from 38 mm CL (De Ranieri *et al*., 1996). Reproduction peak is between spring and summer, and females with external eggs are observed in autumn-winter.

6.13.2 Fisheries

6.13.2.1 General description of fisheries

Norway lobster is one of the most important components of bottom trawlers catch in the GSA 09, as total annual value of the landings.

The trawlers fleet of GSA 09 at the end of 2009 accounted for 339 vessels (Tab. 6.13.2.1.1). From those vessels, only a fraction targets *Nephrops norvegicus.*

The main trawl fleets of GSA 09 are present in the following continental harbours: Viareggio, Livorno, Porto Santo Stefano (Tuscany), Fiumicino, Terracina, Gaeta (Latium).

Tab. 6.13.2.1.1 Technical characteristics of the trawl fleet of GSA 09 (year 2010, DCR official data).

N. of boats	339
GT	12.484
kW	70.794
Mean GT	36.8
Mean kW	208.8

The majority of bottom trawlers of GSA 09 operate daily fishing trips with only some vessels that stay out at sea fishing for two-three days (especially in summer).

Norway lobster fishing grounds include soft bottoms of upper slope, generally between 350 and 600 m depth. Fishing pressure shows some geographical differences inside the GSA 09 according to the consistency of the fleets, the availability of the resources and the morphology of the continental shelf and upper slope. The species by-catch is mainly represented by *Micromesistius poutassou, Phycis blennoides, Lepidorhombus bosci, Galeus melastomus, Parapenaeus longirostris, Eledone cirrhosa, Todaropsis eblane, Trachurus spp.*

6.13.2.2 Management regulations applicable in 2010 and 2011

- Fishing closure for trawling: 45 days in late summer (not every year have been enforced).
- Minimum landing sizes: EC regulation 1967/2006: 20 mm CL for Norway lobster.
- Cod end mesh size of trawl nets: 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

6.13.2.3 Catches

6.13.2.3.1 Landings

Landings of Norway lobster in GSA 09 are almost exclusively provided by trawling (Tab. 6.13.2.3.1.1). In the last five years the total landings varied between 289 and 162 tons.

Tab. 6.13.2.3.1.1 Landings (in tons) of Norway lobster in GSA 09 by fishing technique as officially reported through the 2011 DCF data call.

SPECIES	AREA	COUNTRY	FT_LVL4	FT_LVL5	2004	2005	2006	2007	2008	2009	2010
NEP	9	ITA			5	2	1				
NEP	9	ITA	FPO	DEMSP							
NEP	9	ITA	GNS	DEMSP	0	0	0				0
NEP	9	ITA	GNS	SLPF							
NEP	9	ITA	GTR	DEMSP		0				0	0
NEP	9	ITA	LLD	LPF	0	0					
NEP	9	ITA	OTB	DEMSP	76	14	18	45	143	159	82
NEP	9	ITA	OTB	DWSP					1		3
NEP	9	ITA	OTB	MDDWSP	193	273	229	215	84	91	77
NEP	9	ITA	PS	SPF	0						
Total					274	289	248	260	228	250	162

Landings are mostly composed by specimens from 25 to 50 mm CL (Fig. 6.13.2.3.1.2) which correspond to individuals over 2+. Due to the sexual dimorphism of the species, the majority of the specimens greater than 40 mm CL are males.

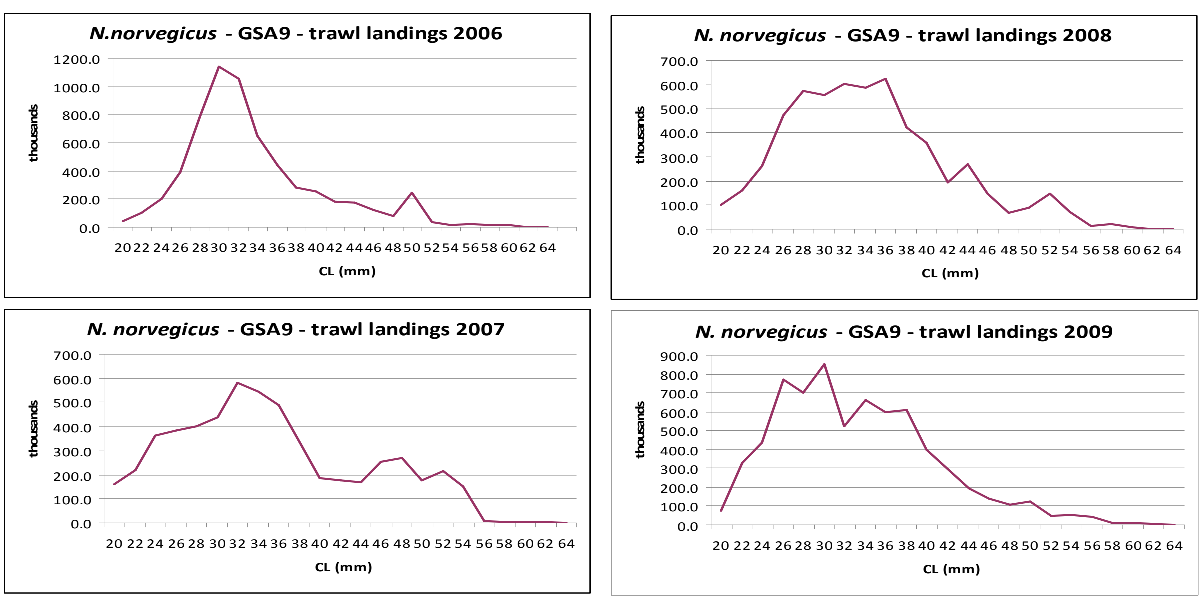


Fig. 6.13.2.3.1.1 Size structure of the landings of *N. norvegicus* in 2006-2009 caught by otter trawling in the GSA 09 (DCF official data).

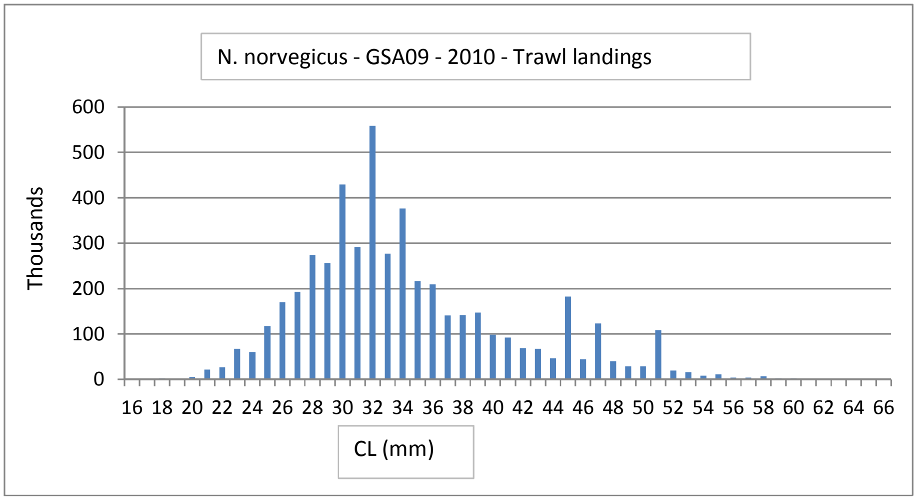


Fig. 6.13.2.3.1.2 Size structure of the landings of *N. norvegicus* in 2010 by otter trawling in the GSA 09 (DCR official data).

6.13.2.3.2 Discards

Several EU and national projects carried out in GSA 09 highlighted that discard of Norway lobster in GSA 09 is negligible. At the same time, the presence of specimens under the MLS (20 mm CL) in the landings is very scarce. The same picture was obtained during the monitoring of discard performed in the 2006 DCR.

The data collected on discards in the framework of DCF in 2009 and 2010 showed total amount of discards of 10 and 1.5 tons, respectively, by otter trawl fleet in GSA 09.

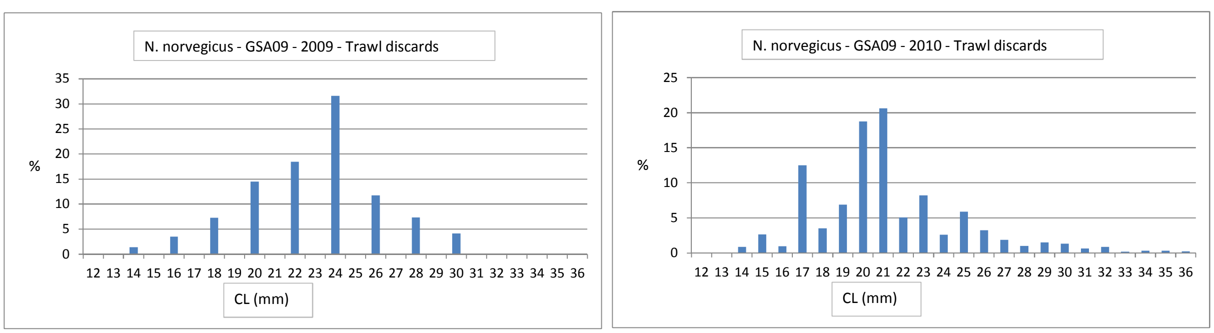


Fig. 6.13.2.3.2.1 Size structure of the discards of *N. norvegicus* in 2009-2010 caught by otter trawling in the GSA 09 (DCR official data).

6.13.2.4 Fishing effort

The fishing capacity of the GSA 09 has shown in these last 10 years a progressive decrease. From 1996 to 2010 the number of bottom trawlers of GSA 09 decreased of about 30%.

The total fishing days carried out by all the GSA 09 trawlers varied from about 65,000 in 2004 to about 63,000 in 2006. A little decrease of the mean number of fishing days/year per vessel was observed in this period, from 187 to 177. Anyway, there is no information on the specific effort directed to *N. norvegicus* in GSA 09.

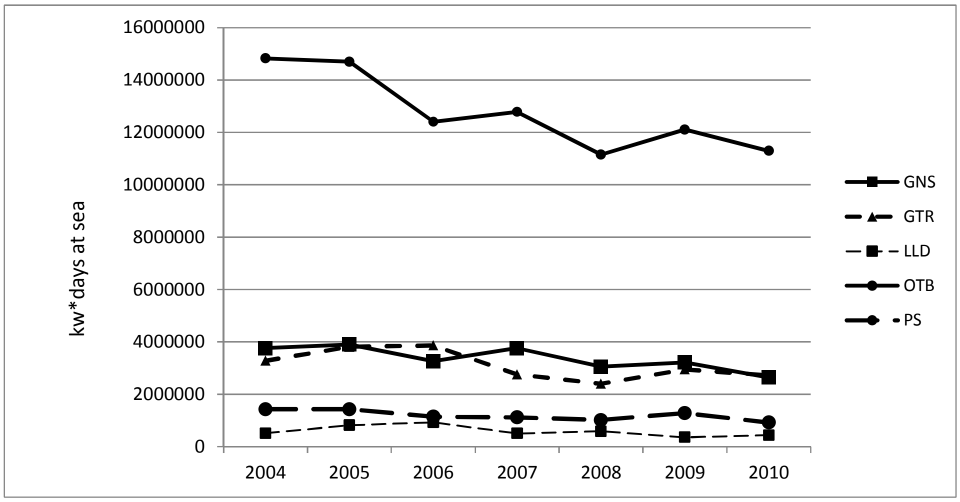


Fig. 6.13.2.3.3.1 Effort trends (kW*days) in 2004-2010 by major fleets for GSA 09.

Table. 6.13.2.3.3.1 Effort trends (kW*days) in GSA 09 as reported through the official 2011 DCF data call.

Type FT - LVL4	2004	2005	2006	2007	2008	2009	2010
GNS	3758318	3902723	3260681	3755597	3054945	3216541	2641506
GTR	3281736	3814641	3861674	2760530	2403569	2948897	2719155
LLD	510386	821542	927993	507078	585762	358051	434722
OTB	14824084	14700599	12404787	12780491	11149391	12107652	11291098
PS	1424338	1426304	1146586	1116579	1017985	1283965	920985

6.13.3 Scientific surveys

6.13.3.1 MEDITS

6.13.3.1.1 Methods

STRATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA09_010-050	21	20	20	20	21	20	20	19	15	14	15	16	15	15	16	16	15
GSA09_050-100	21	21	20	20	20	21	22	23	17	18	17	16	18	18	16	16	19
GSA09_100-200	38	40	40	40	39	39	38	38	30	30	30	31	29	30	31	31	29
GSA09_200-500	40	40	42	42	41	41	42	41	32	33	36	35	36	37	34	34	35
GSA09_500-800	33	32	31	31	32	32	31	32	26	25	22	22	22	20	23	23	22

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 09 the following number of hauls was reported per depth stratum (s. Tab. 6.13.3.1.1.1).

Tab. 6.13.3.1.1.1. MEDITS survey. Number of hauls per year and depth stratum in GSA 09, 1994-2010.

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modeled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report

6.13.3.1.2 Geographical distribution patterns

Norway lobster is distributed in the whole GSA 09 with the highest abundance in the south Ligurian Sea and northern Tyrrhenian Sea. It is distributed on muddy bottoms mainly between 300 and 500 m depth.

6.13.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the *N. norvegicus* in GSA 09 was derived from the international survey MEDITS. Figure 6.13.3.1.3.1 displays the re-estimated trend in *N. norvegicus* abundance and biomass in GSA 09 based on the DCR data call. While there appears no overall trend evident both indices of abundance and biomass in 2009 represent the maximum since 1994.

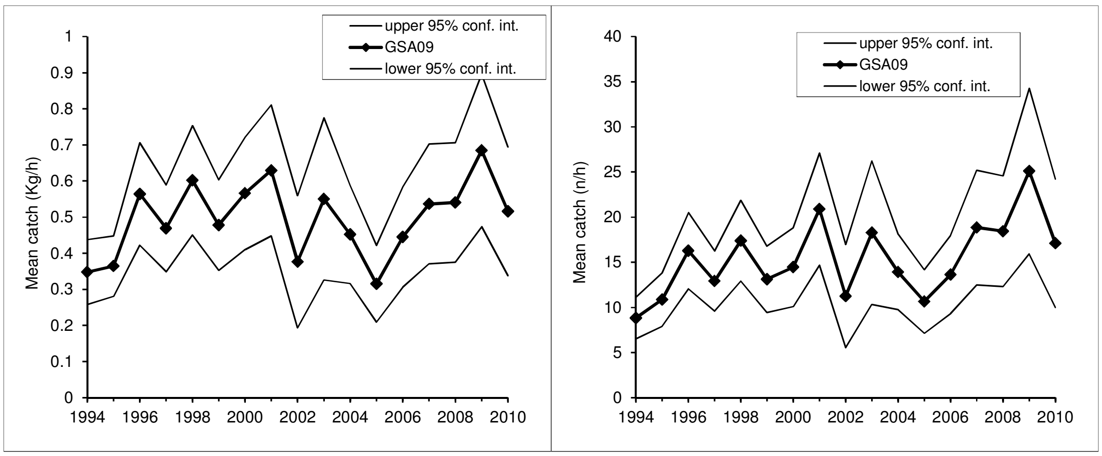


Fig. 6.13.3.1.3.1 Abundance and biomass indices of *Nephrops norvegicus* in GSA 09.

6.13.3.1.4 Trends in abundance by length or age

The following Fig. 6.13.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 in 1994-2001 and 2002-2009.

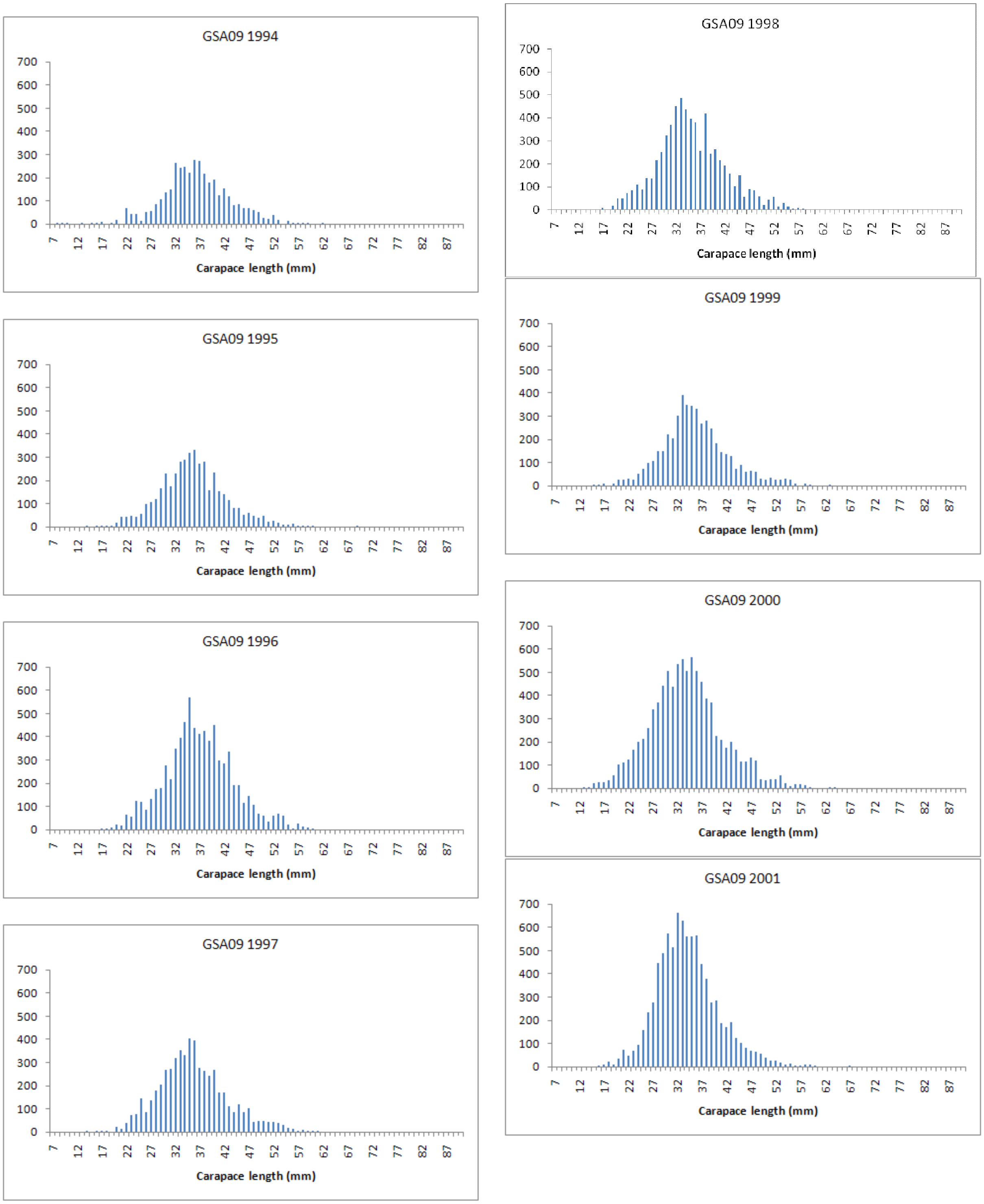


Fig. 6.13.3.1.4.1 Stratified abundance indices by size, 1994-2001.

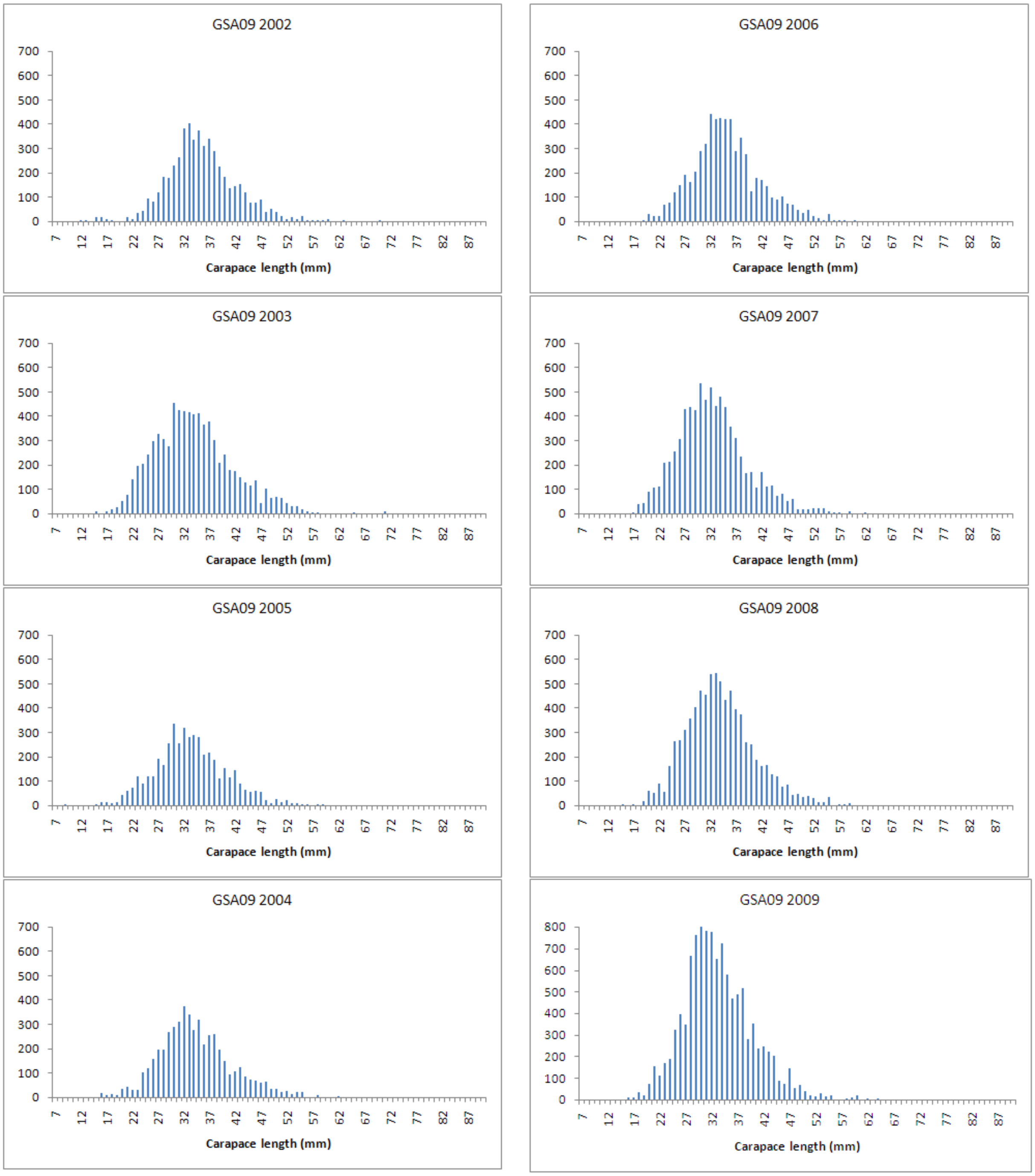


Fig. 6.13.3.1.4.2 Stratified abundance indices by size, 2002-2009.

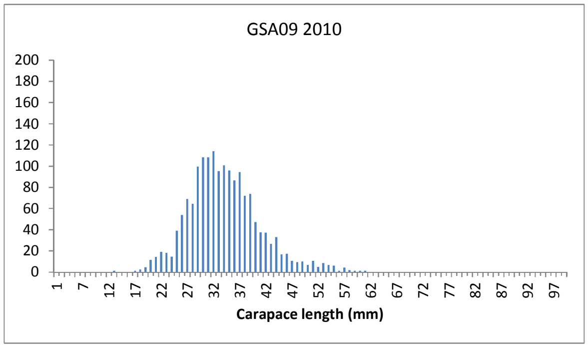


Fig. 6.13.3.1.4.3 Stratified abundance indices by size, 2010.

6.13.3.1.5 Trends in growth

No information was been documented.

6.13.3.1.6 Trends in maturity

No information was been documented.

6.13.3.2 GRUND survey

6.13.3.2.1 Methods

The national GRUND trawl survey (Relini, 1998) is regularly carried out along the Italian coasts in addition to MEDITS. It has been carried out since 1985, with some years lacking (1988, 1989 and 1999). Sampling is random stratified, except in the period 1990-93 where a different sampling design, based on transects, was applied. Locations of stations were selected randomly within each stratum in the period 1985-87, while since 1996, the same stations were sampled every year. Therefore from 1994 two trawl surveys are regularly carried out in Italy each year: MEDITS, in spring, and GRUND, in autumn. The two surveys provide integrate pictures on different seasons, allowing to monitor the most important biological events (recruitment, spawning) for the majority of the demersal species.

6.13.3.2.2 Geographical distribution patterns

Norway lobster is distributed in the whole GSA with the highest abundance in the south Ligurian Sea and northern Tyrrhenian Sea.

6.13.3.2.3 Trends in abundance and biomass

Fig. 6.13.3.2.3.1 shows the density and biomass indices of Norway lobster obtained from 1994 to 2008. The GRUND data series show a fluctuating trend and quite stable trend till 2006, while in 2008 values considerably lower than those of the previous years were recorded.

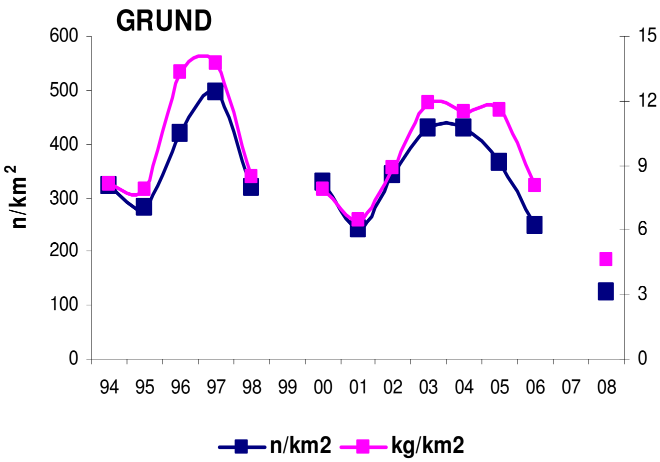


Fig. 6.13.3.2.3.1 Density and abundance indices of *N. norvegicus* obtained from GRUND survey.

6.13.3.2.4 Trends in abundance by length or age

Not presented to STECF EWG 11-12.

6.13.3.2.5 Trends in growth

No analyses were conducted during STECF EWG 11-12.

6.13.3.2.6 Trends in maturity

No analyses were conducted during STECF EWG 11-12 meeting.

6.13.4 Assessments of historic stock parameters

Due to its importance as demersal resource, *N. norvegicus* has been object of several assessments in the GSA 09 (Ardizzone *et al*., 1998; Abella & Righini, 1995; 1998; Abella *et al*., 1999; 2002; 2007; Biagi *et al*., 1990a; 1990b; 1990c; De Ranieri 1999; Mori *et al*., 1993; 1998; Sartor *et al*., 2003, Sbrana *et al*., 2003). These results are published and have been regularly updated in the GFCM SAC. The assessments performed with different approaches in different periods or in different subareas of the GSA 09 showed divergent results as *Nephrops* grounds within GSA 09 are not exploited with the same rate. It is likely that the current status (abundance and demographic structure) may depend mainly on the fishing pressure exerted in the different sub areas of the GSA. This fact does not exclude the possibility of drifting of eggs and larvae from one ground to others contributing to recruitments in grounds different from the parental ones.

The Norway lobster in the GSA 09 is currently overexpolited, as shown by the results of the analytical models (reference points as F_{max}, $F_{0.1}$ and SSB_{curr}/SSB_0). The production models based on Z provided total mortality estimates for the whole GSA 09 greater than the mortality corresponding to the maximum biological production (Z_{MBP}).

A clear growth overfishing is not observed, considering that the smaller individuals, 0+ and 1+ age classes, even though present in the fishing grounds, show a limited vulnerability to the fishing gear. The values of the SSB/SSB_0 ratio are between 0.33 and 0.45.

6.13.4.1 Method 1: SURBA

6.13.4.1.1 Justification

The relatively long time series of data available from the MEDITS survey provided the most important data sets for analysis. The survey-based stock assessment approach SURBA (Needle, 2003) was used in previous assessment both on MEDITS (1994-2007) and GRUND (1994-2004) data of the Norway lobster from GSA09.

6.13.4.1.2 Input parameters

The analyses were performed excluding the first age groups, because these are not efficiently sampled by trawl net. The following set of parameters was adopted:

Tab. 6.13.4.1.2.1 Input parameters.

Growth parameters (Von Bertalanffy)
L∞ = 74 mm, carapace length
K = 0.17
to = 0
L*W
a = 0.0005
b = 3.04
Natural mortality
M = 0.4
Catchability (q)
q = 1 for all the age classes
Length at maturity (L50)
L50 = 29 mm

Tab. 6.13.4.1.2.2 Input parameters used for the SURBA model.

Abundance indices					
	Age				
Year	3	4	5	6	7+
1994	60.95	63.56	30.67	12.25	6.96
1995	80.37	72.16	30.41	10.79	8.46
1996	144.07	117.41	27.99	4.66	2.28
1997	97.54	78.18	32.36	13.15	11.05
1998	138.82	107.46	49.73	18.36	10.94
1999	97.65	84.99	32.92	12.56	10.99
2000	143.24	103.06	37.82	17.31	11.70
2001	193.00	118.26	42.60	14.21	9.26
2002	89.48	75.40	29.72	11.08	5.92
2003	133.35	87.24	36.74	17.39	12.05
2004	111.04	76.46	29.06	12.39	9.34
2005	96.33	59.50	27.53	8.59	5.16
2006	118.94	94.29	33.57	14.53	8.13
2007	177.22	84.96	31.54	12.32	7.34
2008	151.37	107.78	41.73	13.95	9.24
2009	171.25	82.30	24.40	10.50	3.93
2010	82.15	42.79	14.62	6.86	4.10

Mean weight					
	Age				
Year	3	4	5	6	7+
1994	50.8	72.5	95.2	117.8	139.5
1995	50.8	72.5	95.2	117.8	139.5
1996	50.8	72.5	95.2	117.8	139.5
1997	50.8	72.5	95.2	117.8	139.5
1998	50.8	72.5	95.2	117.8	139.5
1999	50.8	72.5	95.2	117.8	139.5
2000	50.8	72.5	95.2	117.8	139.5
2001	50.8	72.5	95.2	117.8	139.5
2002	50.8	72.5	95.2	117.8	139.5
2003	50.8	72.5	95.2	117.8	139.5
2004	50.8	72.5	95.2	117.8	139.5
2005	50.8	72.5	95.2	117.8	139.5
2006	50.8	72.5	95.2	117.8	139.5
2007	50.8	72.5	95.2	117.8	139.5
2008	50.8	72.5	95.2	117.8	139.5
2009	50.8	72.5	95.2	117.8	139.5
2010	50.8	72.5	95.2	117.8	139.5

Proportion of mature					
	Age				
Year	3	4	5	6	7+
1994	1	1	1	1	1
1995	1	1	1	1	1
1996	1	1	1	1	1
1997	1	1	1	1	1
1998	1	1	1	1	1
1999	1	1	1	1	1
2000	1	1	1	1	1
2001	1	1	1	1	1
2002	1	1	1	1	1
2003	1	1	1	1	1
2004	1	1	1	1	1
2005	1	1	1	1	1
2006	1	1	1	1	1
2007	1	1	1	1	1
2008	1	1	1	1	1
2009	1	1	1	1	1
2010	1	1	1	1	1

6.13.4.1.3 Results

Fitted year effect shows strong fluctuations from year to year with a high increases from 2006, while the age effect shows a flat-topped selection pattern for stock mortality with an increase from age 3 to age 6. Fitted cohort effects showed a decreasing trend during the last years.

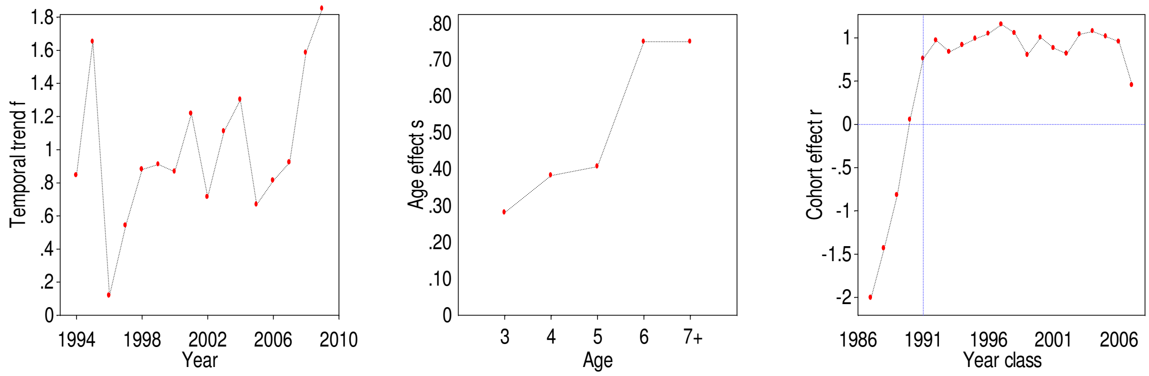


Fig. 6.13.4.1.3.1 MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

SURBA fishing mortality ($F_{3\text{-}6}$) estimated with MEDITS fluctuated between 0.05 in 1994 and 0.84 in 2009. Relative spawning stock biomass (SSB) indices showed a fluctuating trend with two main peaks in 2001 and 2008 (Fig. 6.13.4.1.3.2).

Young of the year are poorly captured by the commercial fleet and during surveys. Relative indices for ages 2+, obtained from MEDITS survey indicated a general stable trend (Fig. 6.13.4.1.3.2).

Ligas *et al.* (2010) obtained a similar trend for *N. norvegicus* recruits (CL < 20 mm) combining GRUND and MEDITS data (1994-2008) from northern and Central Tyrrhenian Sea (Southern part of GSA09).

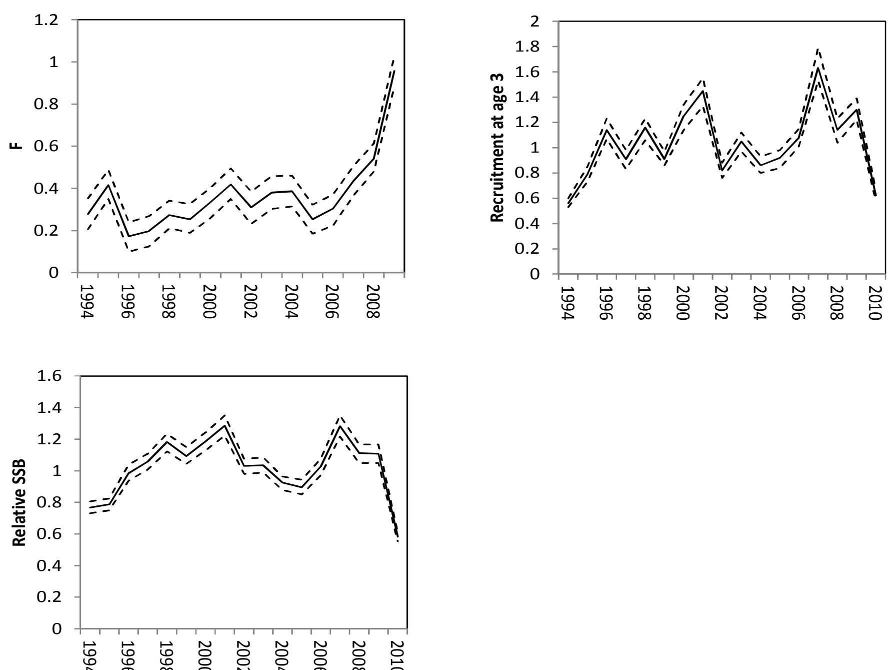


Fig. 6.13.4.1.3.2 MEDITS survey. SURBA estimates of mean $F_{3\text{-}6}$, SSB, and recruitment at age 3.

Model diagnostics are shown in the Fig. 6.13.4.1.3.3.

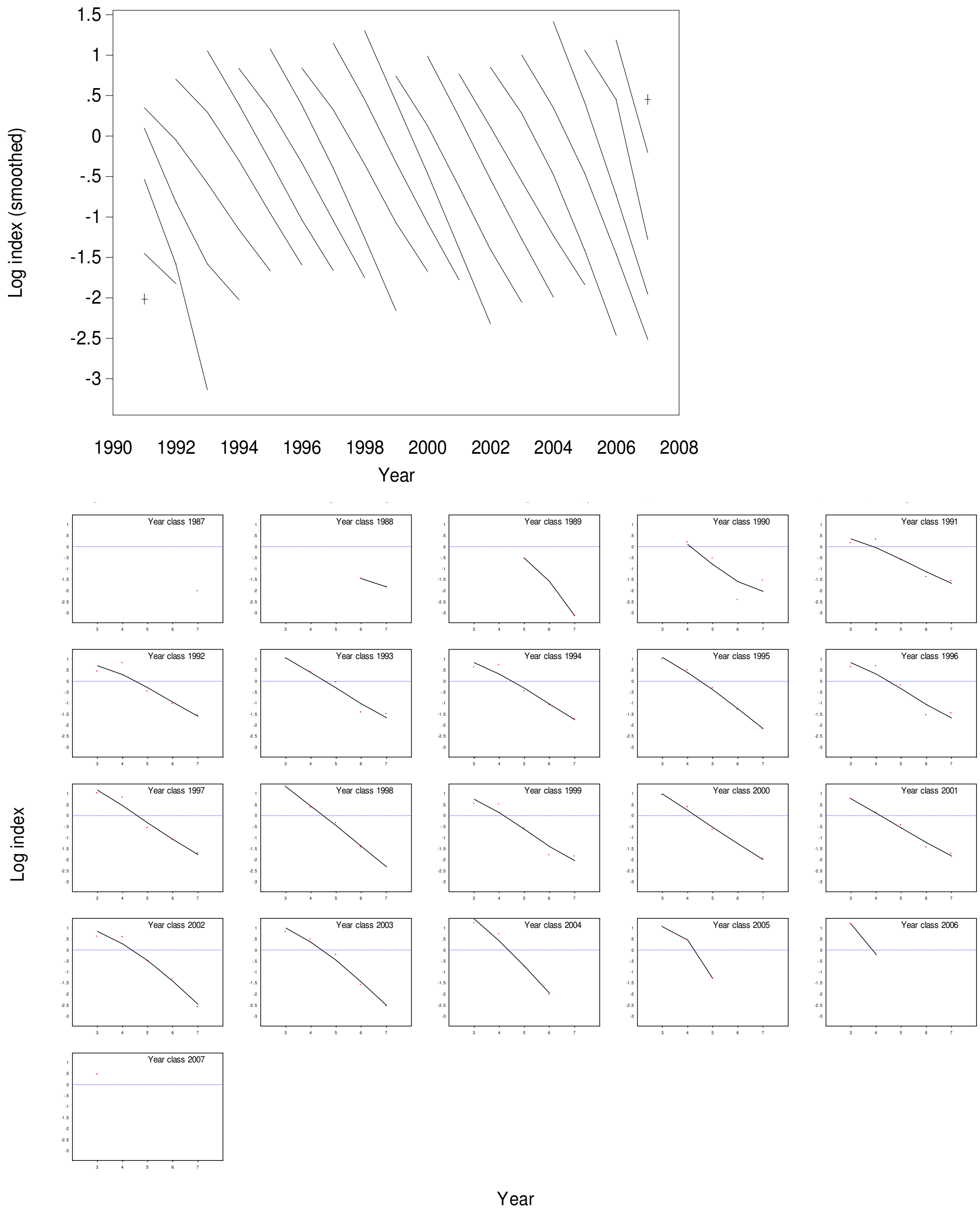


Fig. 6.13.4.1.3.3. Model diagnostic for Surba model in the GSA 09. a) Comparison between observed (points) and fitted (lines) of MEDITS survey abundance indices, for each year. b) Log survey abundance indices by cohort. Each line represents the fitted log index abundance of a particular cohort throughout its life.

6.13.4.2 Method 2: LCA on DCF data

6.13.4.2.1 Justification

Assessment was performed using an LCA (VIT software, Lleonart and Salat 1997) on an annual pseudocohort (2006-2010). During STECF-EWG 11-12 a new LCA was performed using DCF data for 2010.

6.13.4.2.2 Imput parameters

Data coming from DCR provided at STECF-EWG 11-12 contained information on landings and the respective size/age structure for 2006-2010. The short data time series did not allow the application of VPA.

LCA was performed using VIT software on data of the years 2006, 2007, 2008, 2009 and 2010. Tab. 6.13.4.2.2.1 shows the input data. The used parameters were the same of the SURBA analysis, including the M-vector and the maturity ogive.

Tab. 6.13.4.2.2.1. Input data for LCA of the Norway lobster in GSA 09, 2006-2009.

Carapace length	2006	2007	2008	2009
14		2.5	3.7	
16	0.0	2.5	11.7	
18	0.0	16.0	63.9	16.9
20	45.3	160.7	103.2	75.5
22	99.3	221.2	159.9	330.9
24	203.2	363.4	260.8	438.2
26	388.2	384.0	473.2	772.3
28	790.4	401.4	572.2	703.0
30	1139.5	439.4	558.0	853.2
32	1055.9	581.5	603.3	521.7
34	650.3	543.6	587.2	663.2
36	444.0	490.6	622.7	597.4
38	279.5	331.6	423.3	608.3
40	252.8	187.5	357.8	400.7
42	177.3	178.5	192.3	294.1
44	173.5	167.7	271.7	195.5
46	120.5	253.8	147.1	140.7
48	82.3	269.7	66.2	105.5
50	249.3	175.9	89.5	122.3
52	34.4	213.8	148.8	50.3
54	14.8	151.6	70.5	52.8
56	18.5	10.1	14.3	41.2
58	16.4	4.2	19.7	10.9
60	12.2	5.0	8.8	11.4
62	0.0	2.9	1.9	3.7
64	0.0	0.4	0.5	0.9

Tab. 6.13.4.2.2.2. Input data for LCA of the Norway lobster in GSA 09, 2010.

Carapace length (mm)		Carapace length (mm)	
14	2.0	38	141.8
15	6.2	39	147.4
16	3.4	40	98.4
17	29.8	41	92.4
18	10.2	42	69.1
19	17.0	43	67.8
20	49.0	44	45.9
21	69.9	45	182.8
22	38.7	46	44.6
23	86.9	47	123.4
24	66.2	48	39.6
25	131.5	49	29.1
26	177.5	50	29.2
27	197.6	51	107.9
28	275.5	52	19.2
29	259.4	53	15.7
30	432.2	54	7.9
31	292.0	55	10.8
32	560.3	56	4.2
33	277.5	57	3.8
34	377.0	58	6.7
35	216.8	59	3.1
36	209.9	60	4.1
37	141.0		

6.13.4.2.3 Results

The general results of LCA (Fig. 6.13.4.2.3.1) show mean values of F (3-6) ranging from 0.58 (in 2009) and 0.34 (in 2010), very similar to those estimated with SURBA (with the only exception of the last increase in F observed including the 2010 Medits data).

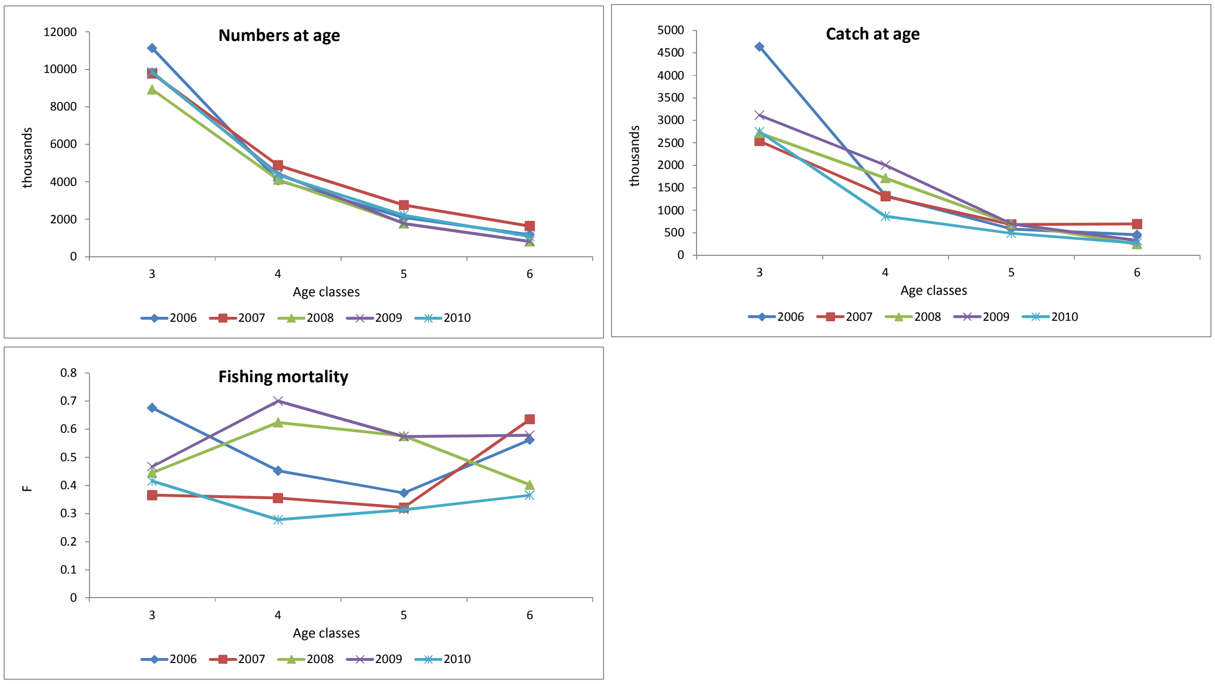


Fig. 6.13.4.2.3.1. LCA outputs: numbers at age, catch at age and fishing mortality at age of *N. norvegicus* in GSA 09.

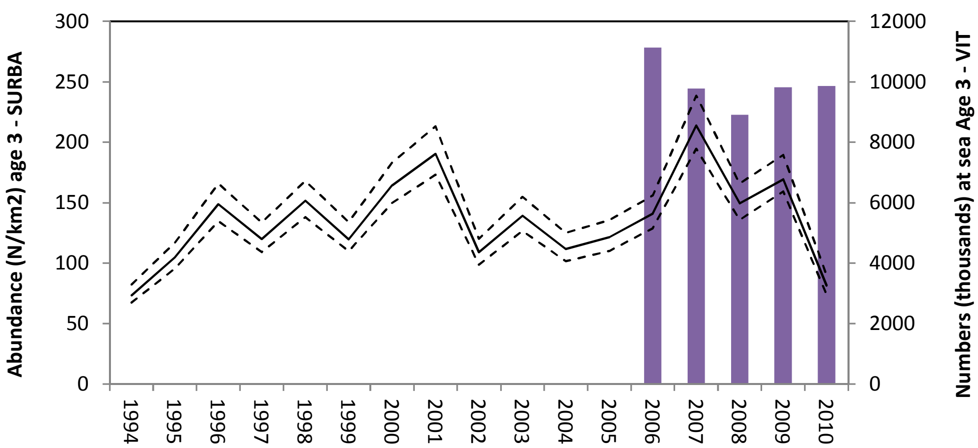


Fig. 6.13.4.2.3.2. Comparison between SURBA estimates of abundance-at-age 3 and numbers at sea for age 3 estimated from landing data for 2006-2010.

6.13.5 Long term prediction

6.13.5.1 Method 1: Y/R analysis

6.13.5.1.1 Justification

Equilibrium Y/R reference points for the stock estimated through the Yield software (Hoggarth *et al*., 2006) which assumes recruitment fluctuating randomly around a constant value and 20% uncertainty in input parameters. Further YPR analyses were conducted based on the VIT (pseudocohort) results.

6.13.5.1.2 Input parameters

Parameters used were the same imputed for SURBA and LCA analyses.

6.13.5.1.3 Results

Yield software quantified uncertainty by repeatedly selecting a set of biological and fishery parameters by sampling from the probability distributions for uncertain parameters set by the user, and then calculating the quantities of interest. In this sampling, it is assumed that each of the uncertain parameters are independently distributed, even though for some biological parameters, this assumption is almost certainly incorrect (Hoggarth *et al*., 2006). F_{max} and F_{01} were assumed respectively as limiting and target reference points. Their probability distributions showed a considerable variation (Fig. 6.13.5.1.3.1). The following median values were obtained: F_{max} = 0.36; F_{01}= 0.21. The maximum predicted values were respectively 0.59 (F_{max}) and 0.30 (F_{01}).

The estimated current F was around 0.34 with a LCA and this suggests that the *N. norvegicus* stock is currently overexploited.

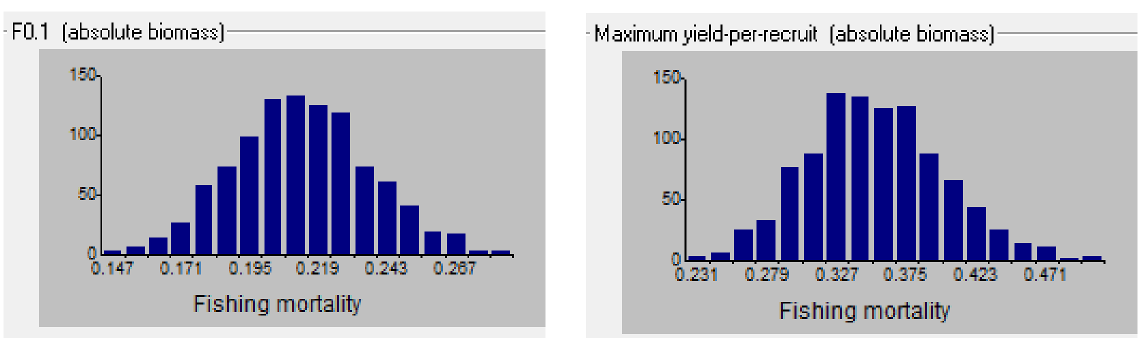


Fig. 6.13.5.1.3.1 Probability distribution of Norway lobster RPs in the GSA 09 obtained using the Yield software.

6.13.6 Data quality and availability

MEDITS survey data were available from 1994. A check of hauls allocation between GSAs 09 and 10 needs to be done before calculation of indices from JRC MEDITS database.

6.13.7 Scientific advice

6.13.7.1 Short term considerations

6.13.7.1.1 State of the stock size

Relative spawning stock biomass (SSB) indices derived from MEDITS (1994-2010) showed fluctuations without a particular trend in the spawning stock biomass (SSB). However, while both indices of abundance and biomass in 2009 showed a peak, the 2010 data showed a sharp decrease.

The STECF EWG 11-12 cannot fully evaluate the state of the SSB due to a lack of precautionary management reference points.

6.13.7.1.2 State of recruitment

Recruitment (age groups 1+ and 2+) followed a significant increasing trend since 1994. However, it is worth to highlight that data collected in 2010 reverse this pattern.

6.13.7.1.3 State of exploitation

The EWG 11-02 proposes the estimated $F_{0.1}$ =0.21 as limit management reference point for sustainable exploitation consistent with high long term yield (F_{MSY} proxy).

Recent values of F_{3-6} obtained on commercial data with LCA (VIT) and using SURBA indicate that the stock is subject to overfishing. STECF-EWG 11-12 recommends a reduction of fishing effort until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings. This can be be achieved by means of a multiannual management plan towards the proposed management reference point in order to avoid long term losses in yield. Such management plan should consider the mixed fisheries implications for the *Nephrops* fisheries. STECF-EWG 11-12 recommends that the resulting catches consistent with the effort reductions have to be determined.

6.14 Stock assessment of common Pandora in GSA 09

6.14.1 Stock identification and biological features

6.14.1.1 Stock Identification

Common pandora is distributed along the shelf of all the Mediterranean countries. The species can be found at depths over 200m. Nurseries are distributed along the narrow Mediterranean shelves. There is not any definition of unit stocks in the Mediterranean sea. Under a management point of view, in the frame of GFCM, it is decided that inside each GSAs boundaries inhabits a single, homogeneous stock that behaves as a single well-mixed and self-perpetuating population. These GSA boundaries are however arbitrary and certaintly do not take under consideration neither the existence of any local biological feature nor of any difference in the spatial allocation in fishing pressure within it. The inability to account for spatial structure reduces flexibility and can lead to uncertainty in the definition of the status of the stocks, due to the possibility of local depletions and to a worse utilization of the potential productivity of the resources.

6.14.1.2 Growth

The species is relatively slow growing. Some light differences in growth speed has been observed within different zones of GSA9. The parameters reported as follows may be considered suitable for the description of an average growth performance valid for the whole GSA9.

Common growth parameters considered representative for *P. erythrinus* in the GSA9 utilized in the successive analyses.

Growth parameters used were L_∞=54.3, K=0.118, t_o=-1.12, L/W a=0.0274 and b=2.9556

An estimate of $M=0.27$, based on growth parameters and estimated longevity was used in the computations

6.14.1.3 Maturity

The species is hermafrodite, reaches the sexual maturity (female) at one year old.

6.14.2 Fisheries

6.14.2.1 General description of fisheries

Pagellus erythinus is a commercially valuable species in the area and is an important component of a species assemblage of the bottom trawling fleets. It is mainly caught by the trawlers operating near shore. A lower fraction of the catches proceed from artisanal fisheries. The main commercial species in this bottom multi-species trawl fishery in GSA9 are *Squilla mantis, Sepia officinalis, Trigla lucerna, Merluccius merluccius, Mullus barbatus, Gobius niger.* Fishing effort have shown a moderate declining in the analyzed period 1994-2010.

The species is mainly caught in late summer-beginnings of autumn. The small mesh size of the cod end of bottom trawl nets in all cases defines a very precocious size/age of first capture. The size of full capture is about 8 cm. Catch is mainly composed by age 0 and 1 individuals while the older age classes are poorly represented in the trawlers catch. Catch rates remained almost stable along the analyzed years. No dramatic changes occurred on effort allocation nor on other aspects of fishing behaviour in this time period. Even if catch within the coastal 3 miles stripe is forbidden, illegal fishing do occur producing an unknown amount of fishing mortality on juveniles of the species. The main concentrations of older individuals are positioned at higher depths than juveniles and over relatively hard bottoms on non trawlable areas.

Set nets catch lower quantitatives of relatively large individuals, in general over 12 cm TL.

About 200 of the 350 trawlers and a big number of artisanal vessels exploit the species in the GSA9. Annual landings, mostly proceeding from trawling, ranged from 146 to 285 tons in the last years (2006-2010). Discards of undersized individuals in bottom trawl fisheries is in general high (about 10% in the years 2009 and 2010).

Tab. 6.14.2.1.1 Landings of *Pagellus erythrinus*

year	Total catch
2006	285.4
2007	146.5
2008	216.3
2009	199.1
2010	171.4

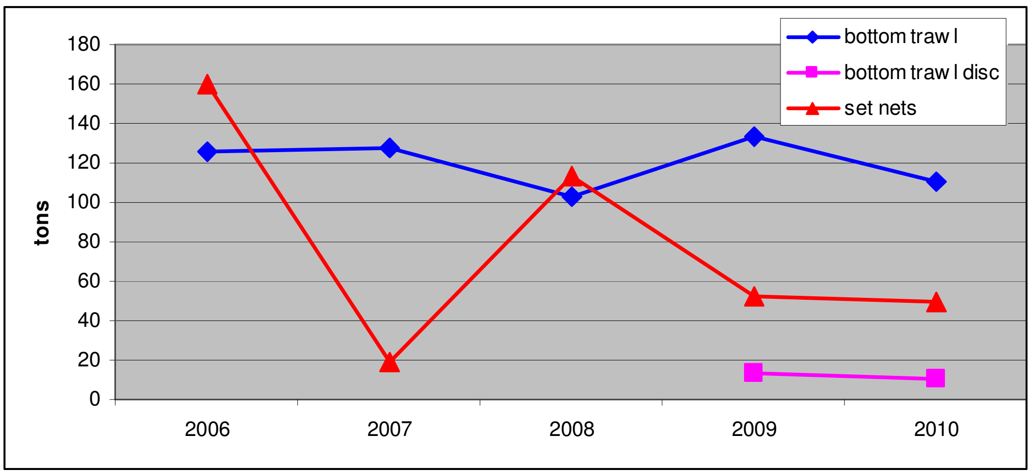


Fig. 6.14.2.1.1 Annual catches and discards by fishing system

Tab. 6.14.2.1.2 OTB landings and discards as well as landings by nets.

	bottom trawl	bottom trawl discard	set nets
2006	125.4		160.0
2007	127.2		19.3
2008	103.2		113.1
2009	133.2	13.4	52.5
2010	110.8	10.7	49.9

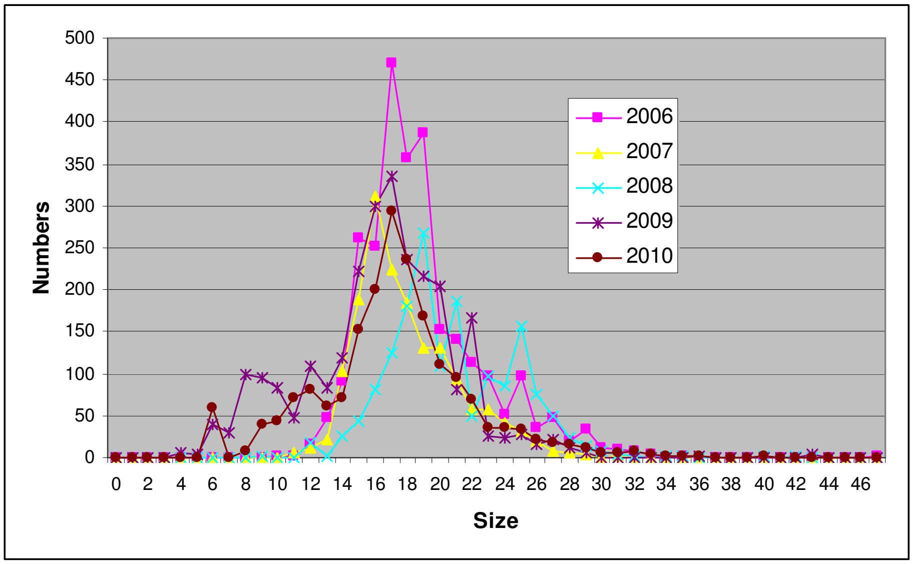


Fig. 6.14.2.1.2 Size distribution of the catches of *Pagellus erythrinus* (only years 2009 and 2010 include discards)

6.14.2.2 Management regulations applicable in 2010 and 2011

Fishing closure for trawling: 45 days in late summer have been enforced certain years for some fleets in GSA9. In 2008 and 2009 was compulsory for all the trawlers in the area.

Minimum landing sizes: EC regulation 1967/2006 defined 12 cm TL as minimum legal landed size for common pandora.

Cod end mesh size of trawl nets: the 40 mm (stretched, diamond meshes) will continue to be utilized up to 30/05/2010. Since 1/6/2010, such cod end will be replaced by a 40 mm square meshes or alternatively by a net with a cod end of 50 mm (stretched) diamond meshes. It is not expected a noticeable increase in the size of entering to the fishery with the introduced changes because this size is only patially defined by the gear but also by the spatial distribution of juveniles.

Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

6.14.2.3 Catches

6.14.2.3.1 Landings

Annual landings varied between 146 and 285 tonnes (Tab. 6.14.2.1.1.). Demersal bottom trawlers dominate the landings by far.

Artisanal fisheries target bigger individuals, but their landings are in general much lower. Official data suggest that only in 2006 landings proceeding from artisanal fisheries appears to predominate.

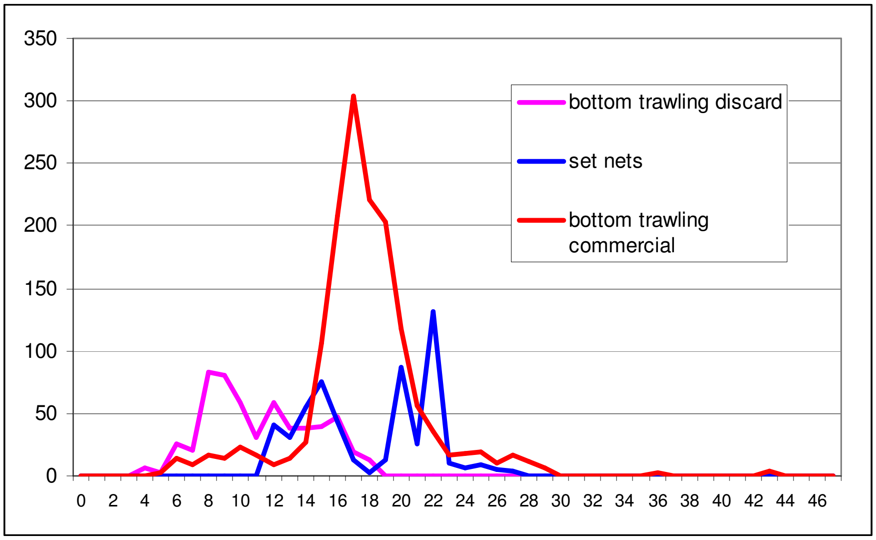


Fig. 6.14.2.3.1 Size structure of landings for trawlers and artisanal fleet for year 2010.

6.14.2.3.2 Discards

Available official data suggest bottom trawling fishery discarded 13.4 tons in 2009 and 10.7 tons in 2010. It is likely that no discard occurs in artisanal fisheries other than some damaged individuals.

6.14.2.4 Fishing effort

Fig. 6.14.2.4.1 lists the effort by fishing technique deployed in GSA 09 as reported throught the DCR data call. A minor decrease is observed for the main gear demersal otter trawl. It is however difficult to extract from these figures the real number of vessels that target common pandara.

In the last 15 years, a general decrease in the size of the fishing fleets operating in the GSA9 targeting demersal species was observed. The number of vessels targeting the species in question and the changes (reduction) in number along the time interval 1990-2007 is only known for some ports of the GSA. The reduction of number of vessels has been particularly important in Porto Santo Stefano fleet (about 50% of reduction) in the South and in Viareggio (about 30%) in the North. It is likely that this general reduction in numbers of vessels also apply for the fraction of the fleet that exert its fishing effort on *M. barbatus* over all the GSA9 fleets. The reduction continued up to 2010.

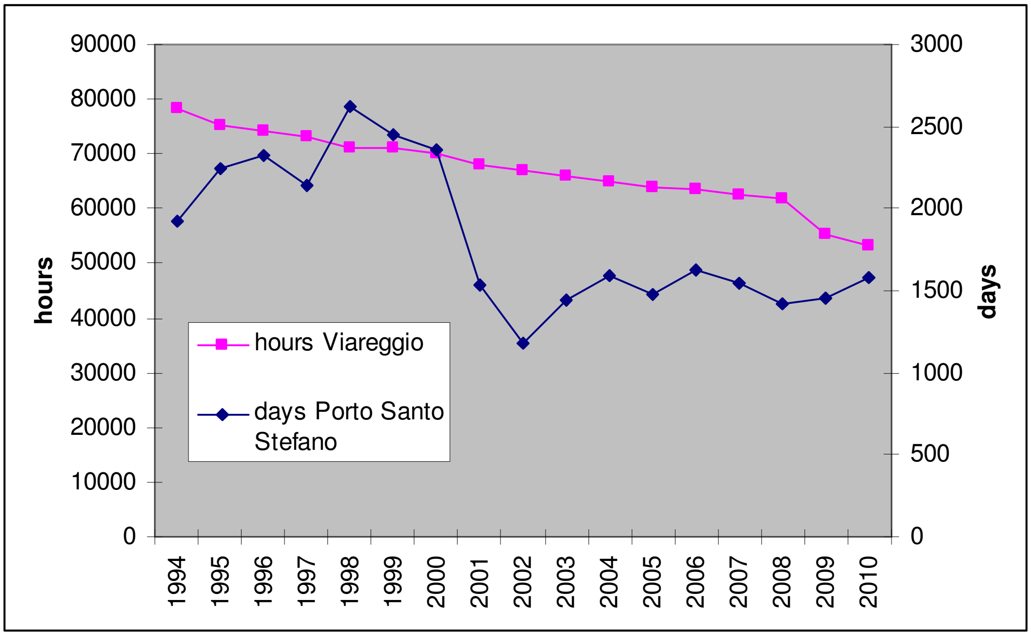


Fig. 6.14.2.4.1 Fishing effort exerted by trawlers in the port of Viareggio (in number of effective hours fishing) and Porto Santo Stefano (in number of days fishing) from 1994 to 2010. The fraction of trawlers fishing on *Pagellus erythrinus* grounds is considered constant in time.

6.14.3 Scientific surveys

6.14.3.1 Medits

6.14.3.1.1 Methods

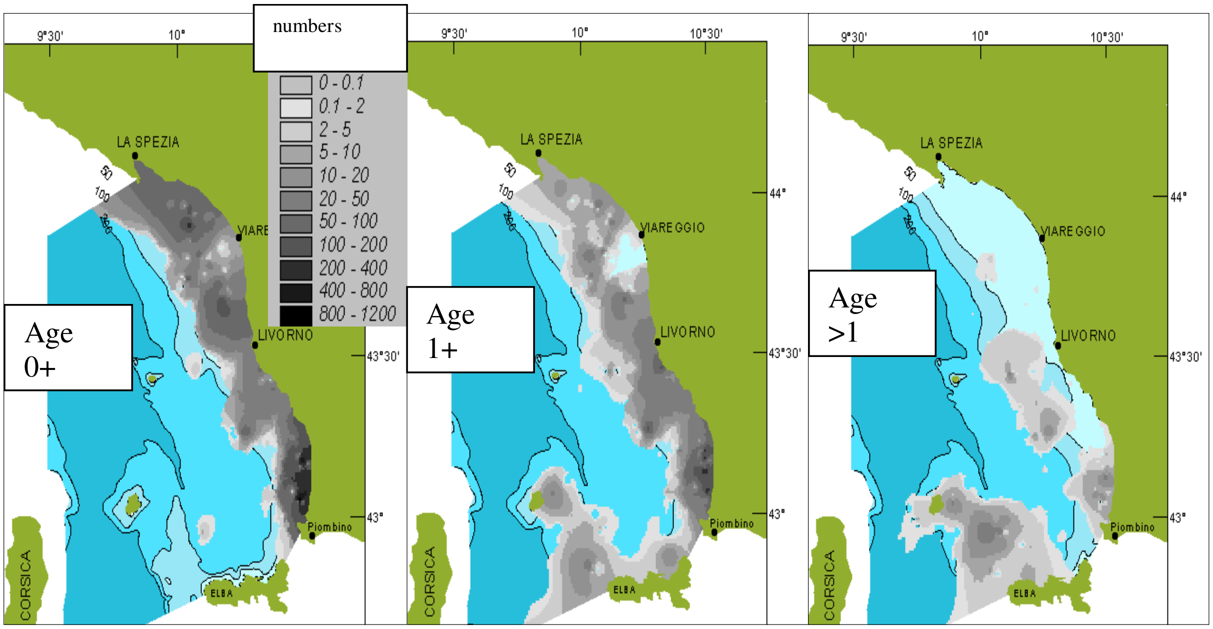
Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls considered valid were only used. Valid hauls include the cases of null catches of the species.

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977).(See MEDITS sampling protocol (Bertrand, 2000)

6.14.3.1.2 Geographical distribution patterns

The species is distributed all along the continental shelf of the GSA9, with major abundance in the depth range 0-100m. The juveniles of this species are highly concentrated in spring-summer along the coastal stripe 0-30m.



Bathimetric distribution of *Pagellus erythrinus* in the central portion of GSA9 showing the shift towards deeper waters of older individuals

6.14.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the common pandora in GSA 09 was derived from the international survey Medits. Figure 6.14.3.1.3.1 displays the estimated trends in biomass index.

The estimated abundance and biomass indices suggest an increasing trend for weight and a stable trend for number of individuals.

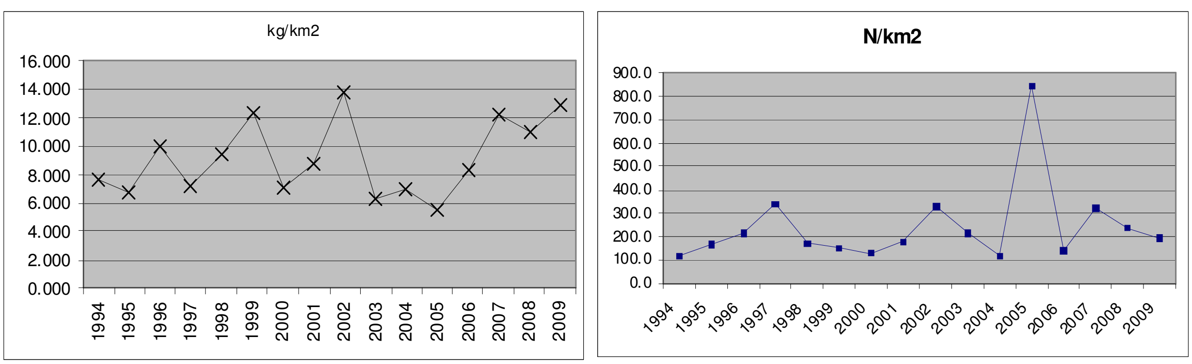


Fig. 6.14.3.1.3.1 Abundance and biomass indices derived from MEDITS for common pandora in GSA 09.

The index of abundance of juveniles shows a high variability, with higher values in years 2000-2003 and with recent levels similar to those of 1994-95.

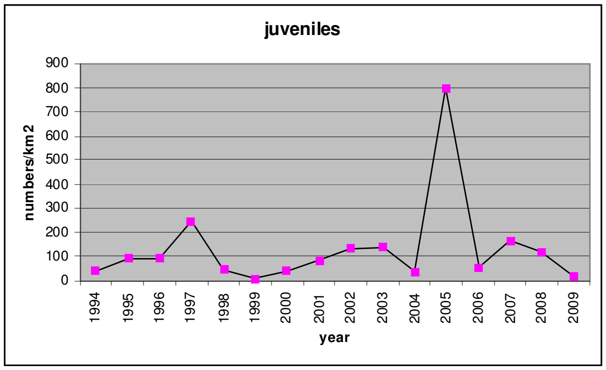


Fig. 6.14.3.1.3.1 Trend in abundance of juveniles.

6.14.3.1.4 Trends in abundance by length or age

The following Fig. 14.3.1.4.1 and 2 display the stratified abundance indices of GSA 09 from 1994-to 2007.

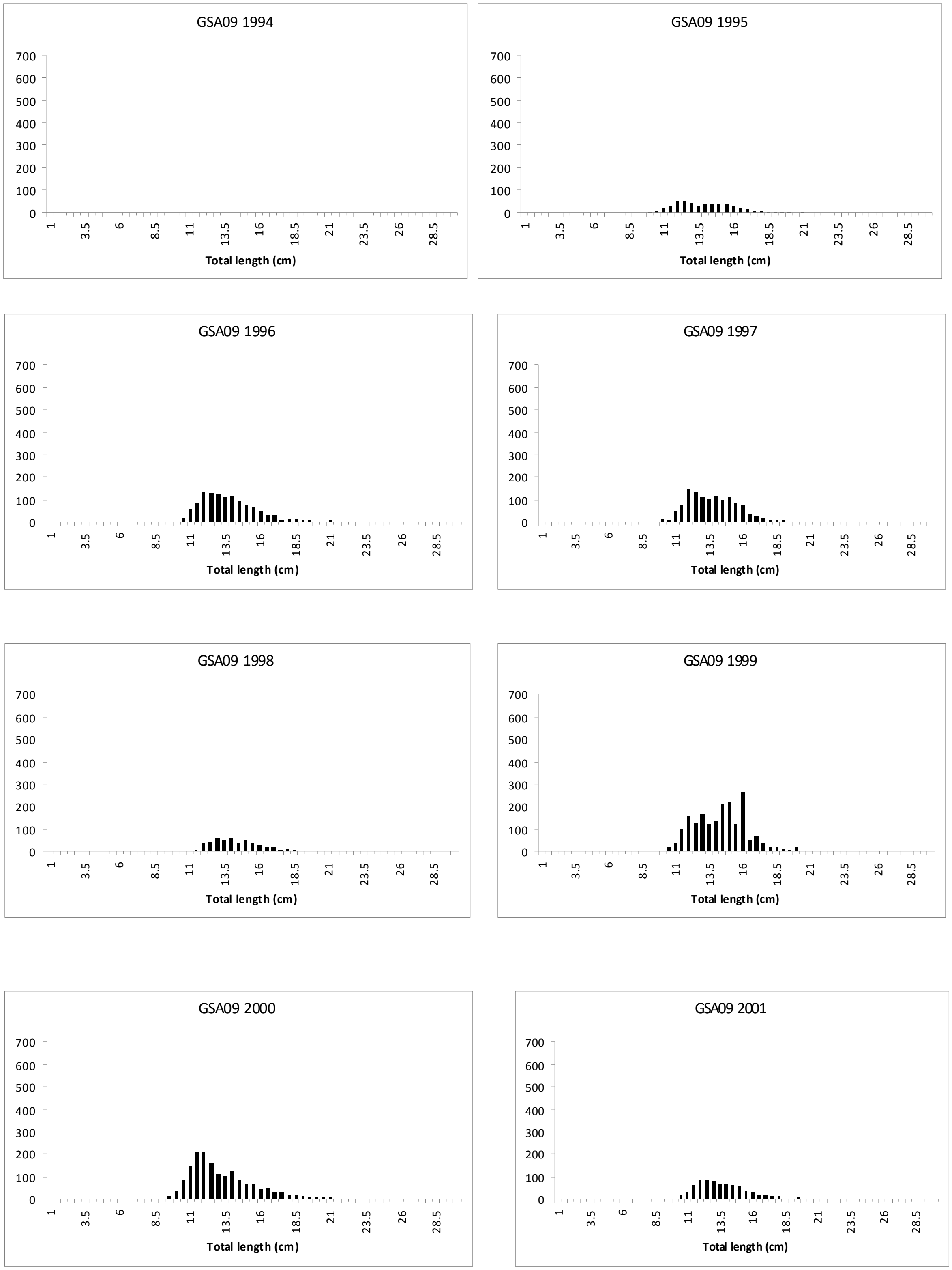


Fig. 14.3.1.4.1 Length composition 1994-2001.

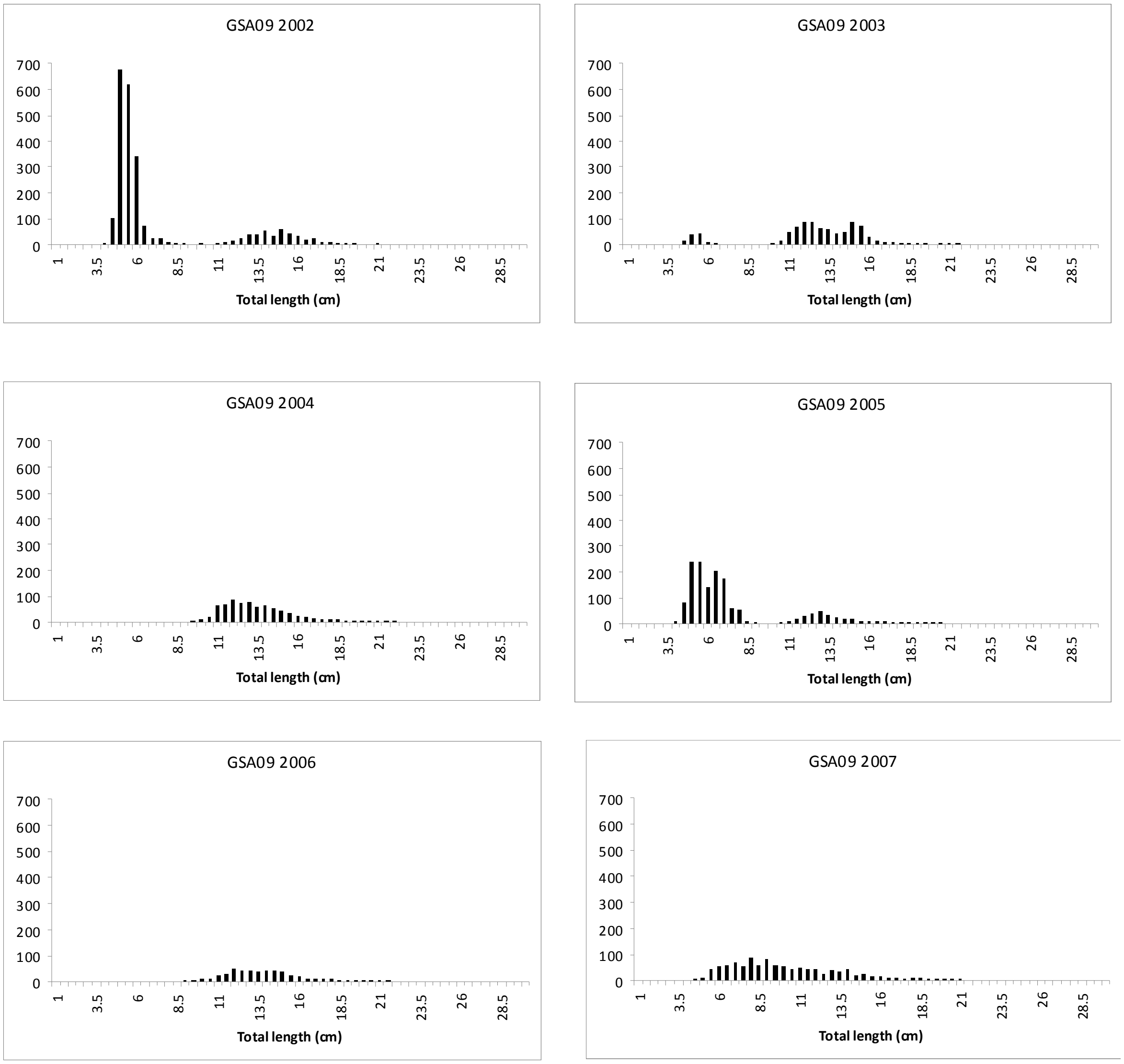


Fig. 14.3.1.4.1 Length composition 2002-2007.

6.14.3.1.5 Trends in growth

No analyses were conducted during EWG-11-12.

6.14.3.1.6 Trends in maturity

No analyses were conducted during EWg 11-12.

6.14.4 Assessment of historic stock parameters

6.14.4.1 Method 1: Length cohort analysis LCA

6.14.4.1.1 Justification

The current fishing mortality rate was estimated through the Length Cohort Analysis implemented on a Excel spreadsheet. The annual catch by size was used in order to derive an *F* vector and mean numbers by size.

6.14.4.1.2 Input parameters

Tab. 6.14.4.1.2.1 Length compostions of landings by gear in 2010.

Size	GNS	GTR	OTB land	OTB disc
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	0	0	0	60
7	0	0	0	0
8	0	0	0	9
9	0	0	0	40
10	0	0	2	41
11	0	0	0	71
12	0	0	0	80
13	0	1	7	54
14	18	1	33	19
15	14	6	104	29
16	7	8	169	16
17	5	11	258	20
18	39	16	178	4
19	24	11	133	0
20	13	13	84	2
21	21	10	63	2
22	13	12	44	0
23	5	10	21	0
24	3	9	23	0
25	0	13	21	0
26	2	12	8	0
27	0	7	11	0
28	0	9	7	0
29	0	7	5	0
30	1	4	2	0
31	0	3	2	0
32	0	3	5	0
33	0	3	0	0
34	0	2	1	0
35	0	1	0	0
36	0	2	0	0
37	0	0	0	0
38	0	0	0	0
39	0	0	0	0
40	0	1	0	0

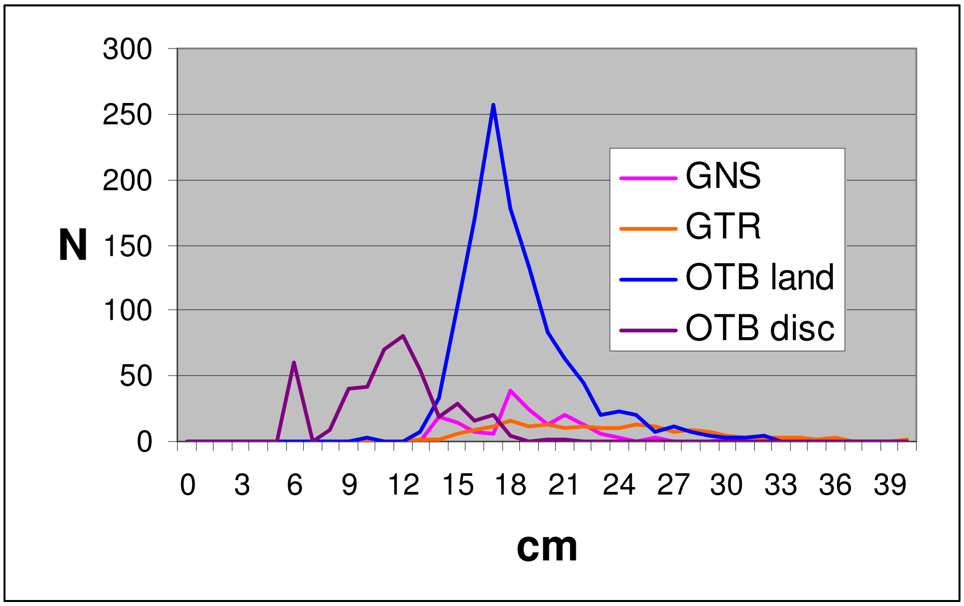


Fig. 6.14.4.1.2.1. Size structure of the catch of *Pagellus erythrinus* using both artisanal gears and bottom trawl nets (the distribution includes discards) in 2010.

6.14.4.1.3 Results

The main results of the cohort analysis are included in the table below. The mean *F* was estimated as the mean (weighted by numbers) for ages 1 to 6.

Tab 6.14.4.1.3.1 Results of LCA and parameters used.

COHORT ANALYSIS WITH VARIABLE M

				average F
				0.64
		SPECIES?->	Pagellus erythrinus	
Loo=	54.3	SEX-->		
K=	0.118			SSB/SSBo
a=	0.027			0.2231
b=	2.9556	Asymptotic M	0.27000	
Lm =	13	B	0.00000	

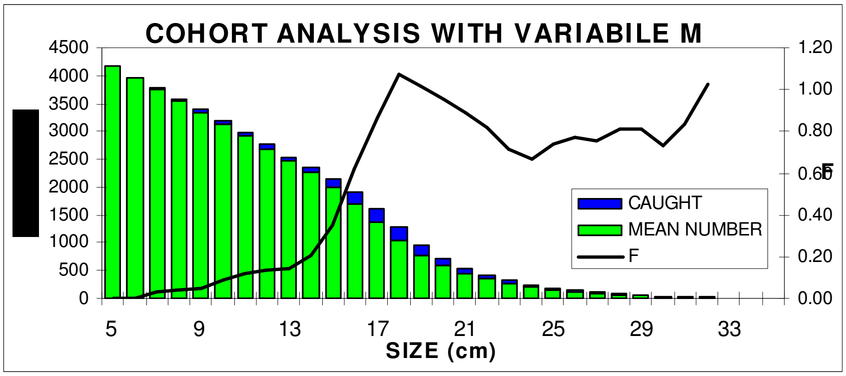


Fig. 6.14.4.1.3.1 Estimated population size structure, proportion caught and fishing mortality at length.

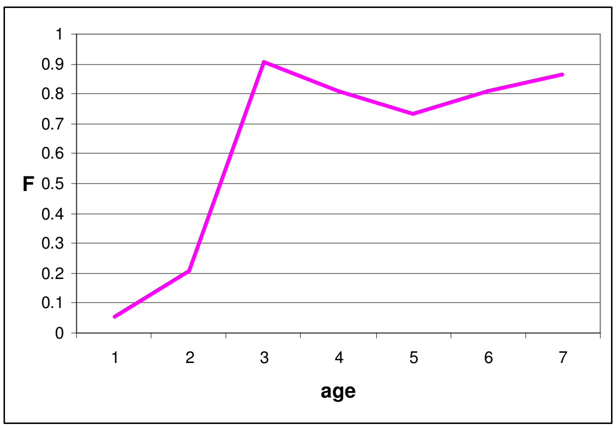


Fig. 6.14.4.1.3.2 *F* at age in 2010.

6.14.4.2 Method 2: Estimates of Z based on mean length (SEINE method)

6.14.4.2.1 Justification

Data used for Z estimation derive from trawl surveys on size composition and abundance indices.

SEINE 1.3.1 software (Survival Estimation in non-equilibrium situations) (Gedamke and Hoenig, 2006) included in the NOAA Stock Assessment Toolbox was used for the estimation of Z, using weigted information of mean size of catch, size of full capture and growth parameters. In this approach, the transitional behavior of the mean length statistic is derived for use in nonequilibrium conditions.

Due to the lacking of a time series of size structure of the commercial catch, data on size distribution of MEDITS surveys were used for analyzing the changes in mean size for an estimation of Z with the mentioned approach. It is assumed that they represent a good approximation of the size structure of the commercial catch, considering that the species is not a target and their catches split in a random way over a wide area where all the age classes are distributed. A critical size of first capture (full recruited individuals) of 8 cm was used in the computations.

Estimation of mortality rates in non-equilibrium situations can be accomplished by selecting a year (or years) of change and the values of Z1, Z2, etc that cause predicted mean lengths from equation to best match a time series of estimated mean lengths. The method of maximum likelihood estimation is used.

6.14.4.2.2 Data

Data used are those of the length cohort analysis above.

6.14.4.2.3 Results

Tab. 6.14.4.2.3.1 Results of SEINE:

Survival Estimation in Non-Equilibrium Situations (SEINE) Version 1.3

Main results of the analysis performed for the estimation of current Z with SEINE.

Date_of_Run: 26_Sept_2011

Time_of_Run: 12:40

Number of Breaks = 1

First Year in Data = 1994

Number of Years = 17

Number of Parameters = 4

AIC = 140.7124

Negative Log Likelihood = 66.3562

VB K = 0.1180

VB Linf = 54.3000

L Crit = 8.0000

Observed & Predicted Lengths and deviation

15.27000000	14.07096985	1.19903015
12.98000000	14.07096985	-1.09096985
13.92000000	14.07096985	-0.15096985
13.89000000	14.07096985	-0.18096985
14.79000000	14.07096985	0.71903015
14.20000000	14.07096985	0.12903015
14.87000000	14.07096985	0.79903015
14.14000000	14.07096985	0.06903015
14.59000000	14.07096985	0.51903015
12.55000000	14.30510122	-1.75510122
15.03000000	14.65871579	0.37128421
15.98000000	14.94987052	1.03012948
14.65000000	15.15565353	-0.50565353
15.53000000	15.29094582	0.23905418
13.66000000	15.37608285	-1.71608285
16.25000000	15.42807708	0.82192292
16.40000000	15.45914246	0.94085754

Total Mortality Estimates
0.78192211

0.61026335

Sigma = 11.99354384

Change Year Estimates

2002.000

The current *F* was estimated with this method as 0.34 (*Z*=0.61 and *M*=0.27),

AIC 140.7124

Likelihood 66.3562

Parameter	Value	STD Deviation
Z 1	0.78192211	0.042763
Z 2	0.61026335	0.042831
Change Year 1	2002.000	N/A
Sigma	11.99354384	2.056900

Fig. 6.14.4.2.3.1 Results of SEINE method.

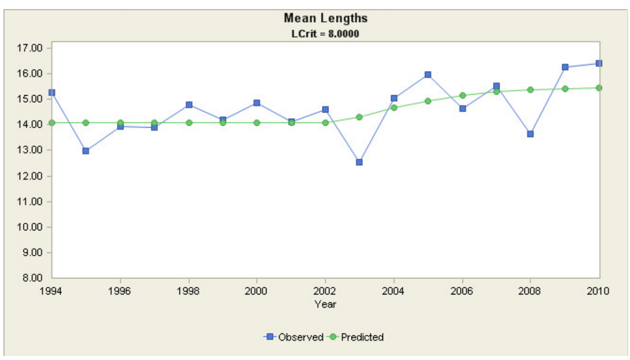


Fig. 6.14.4.2.3.2 Evolution of mean length and residuals of the fitting

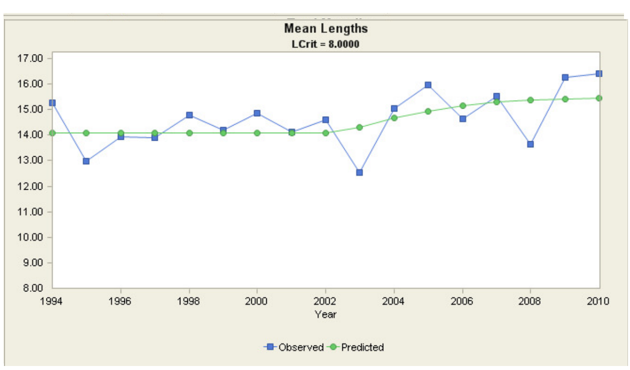


Fig. 6.14.4.2.3.3 Fitting of Z with Beverton & Holt approach with equilibrium assumption (green) and with SEINE (blue)

6.14.5 Long term prediction

6.14.5.1 Justification

A Y/R Thompson & Bell type analysis was performed with the "YPR" software of the NOAA stock assessment toolbox. A weighted average value was used in input. All the analysis were performed as a per-recruit basis, assuming recruitment constant with only a random fluctuation.

6.14.5.2 Input parameters

There were used the growth and L/W parameters defined in tables above. A weighted mean value of M of 0.6 was used instead of an M-at-size vector.

6.14.5.3 Results

Values of Fmax =1.02 and $F_{0.1}$ =0.48 were estimated and the F rate at which the spawning biomass is expected to be reduced to 40% of the pristine Biomass (F40%SSB) was estimated as 0.63

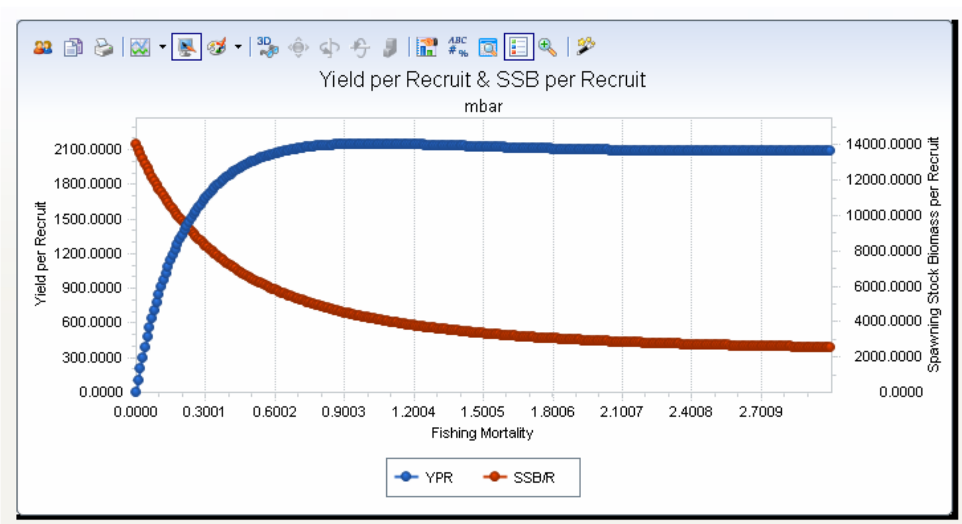


Fig. 6.14.5.3.1 Yield and Spawning Stock Biomass per recruit.

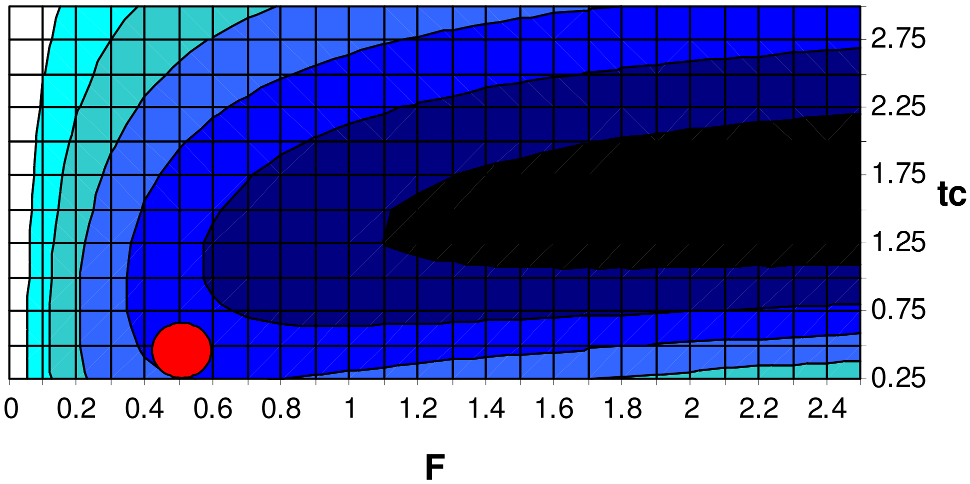


Fig. 6.14.5.3.2.Yield-per-Recruit isopleths. The red circle represents the current combination of *F* and *t*c.

6.14.6 Data quality

Sampling density of trawl surveys is relatively low. Sampling of commercial landings does not pay special attention on this particular species, that often is put in boxes that contain a species mix. Quality of catch assessment surveys however increased in the more recent years.

Using bottom trawl nets hard bottoms are difficult to sample and hence the *Pagellus erythrinus* abundance indices derived from trawl surveys, that does not cover such areas (where is likely abundance is high) may be underestimated, and the reconstruction of the structure by size biased. Commercial data may be more reliable because information proceeds not only from bottom trawlers landings but also from the sampling of the artisanal fisheries that can also operate on hard bottoms.

Recreational fishing removes a non quantified amount of individuals of *Pagellus*, but the impact of such activity is unknown.

6.14.7 Scientific advice

6.14.7.1 Short term considerations

6.14.7.1.1 State of the spawning stock size

The index of stock abundance from surveys shows high variability throughout the time series, but no trend is observed. The index of abundance from MEDITS, suggests a steady situation in numbers but an increase in weight, suggesting an enhancement in the numbers of bigger individuals. This is consistent with which regards the evolution of the mean size in the population. In the absence of a precautionary reference point, STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

6.14.7.1.2 State of recruitment

Recruitment is variable but without any clear trend.

6.14.7.1.3 State of exploitation

STECF EWG 11-12 propses F0.1=0.48 as limit reference point (Fmsy proxy) consistent with high long term yields and low risk of fisheries collapse. The current fishing mortality was estimated as F=0.63 from LCA and exeeds this reference level. The STECF EWG classifies the stock status as being subject to overfishing. EWG 11-12 recommends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

6.15 Stock assessment of blackmouth catshark in GSA 09

6.15.1 Stock identification and biological features

6.15.1.1 Stock Identification

There is not any available definition of unit stocks neither based on genetics, bio-chemistry, fishery-based nor on any alternative method based on somatic features. Under a management point of view, in the frame of GFCM, it has been decided, when the lack of any evidence does not allow suggesting an alternative hypothesis, that inside each one of the GSAs boundaries inhabits a single, homogeneous stock that behaves as a single well-mixed and self-perpetuating population. The same assumption apply for EWG work.

The inability to account for spatial structure however, reduces flexibility and can lead to uncertainty in the definition of the status of the stocks, due to the possibility of local depletions and to a worse utilization of the potential productivity of the resources.

6.15.1.2 Growth

The species is slow growing. The parameters reported as follows may be considered suitable for the description of growth performance valid for the whole GSA9.

Common (both sexes combined) growth parameters considered representative for *G. melastomus* in the GSA9 were utilized in the analyses. Such decision is based on the almost equal size at age that the individuals of both sexes can reach.

Von Bertalanffy's growth parameters $L_\infty = 64$; $K = 0.15$; $t_o = 0$ for both sexes

Length/weight relationship $a = 0.0025$ $b = 3.02$

A constant rate of natural mortality M = 0.20 was adopted based on lifespan and growth parameters.

6.15.1.3 Maturity

The species reaches massively the sexual maturity at 6 years old. The Lm50% and corresponding maturity range (Lm25% - Lm75%) in females and males, respectively is 43.3 (42.3-44.3) and 38.0 (36.6-39.4) cm. Sex ratio is about 1:1

Tab. 6.15.1.3.1 Fecundity at age (max production of number of eggs/year) of *Galeus melastomus* used in the analyses.

Age	Fecundity
0	0
1	0
2	0
3	0
4	0
5	0
6	10
7	12
8	14
9	17
10	20
11	23
12	28
13	33
14	38
15	44

6.15.2 Fisheries

6.15.2.1 General description of fisheries

The blackmouth catshark *Galeus melastomus* is a deep sea species, mainly distributed in the depth range 200-1000m. Locally, the species has a quite low commercial value. The species is exclusively caught with bottom trawl nets, mainly as a by-catch of the Norway lobster fishery, by vessels operating within the 250-500m depth range and in red shrimps fisheries in deeper waters (up to 800m). Only relatively big-sized individuals are landed.

Other involved species of the Nephrops and Red shrimps fisheries are *Phycis blennoides, Micromesistius potassou, Lepidopus caudatus, Trachurus trachurus, Conger conger, Macrouridae, Etmopterus spinax, Gadiculus argenteus, Parapenaeus longirostris.*

6.15.2.2 Management regulations applicable in 2010 and in 2011

Fishing closure for trawling: a 45 days trawling ban was enforced in GSA9 in recent years in late summer. The measure was in the past not compulsory and hence adhesion did not covered all the fleets of the GSA. Only since 2008 it is compulsory for all the trawlers in the area and is expected this measure with the same characteristics will be remain in the future.

Minimum landing sizes: is not defined a minimum legal landed size for blackmouth catshark .

Cod end mesh size of trawl nets of 40 mm (stretched, diamond meshes) has been recently changed by the new adopted cod ends of 40mm with square mesh geometry or alternatively by a net with a cod end of 50 mm stretched diamond meshes. It is not expected a noticeable increase in the size of entering to the fishery of the species with the introduced modest changes.

6.15.2.3 Catches

6.15.2.3.1 Landings

Tab. 6.15.2.3.1 Landings by quarter and fishery in 2009.

	Landings in Kgs 2009			
	1st trimester	2nd trimester	3rd trimester	4th trimester
OTB_DES_>	1345.89	2391.08	158.48	892.73
OTB_MDD_>	305.52	1115.37	2848.18	310.64
	1651.41	3506.45	3118.39	1203.37

Landings are very low and show a high seasonal variability, with peaks in the 2nd and 3rd trimesters.

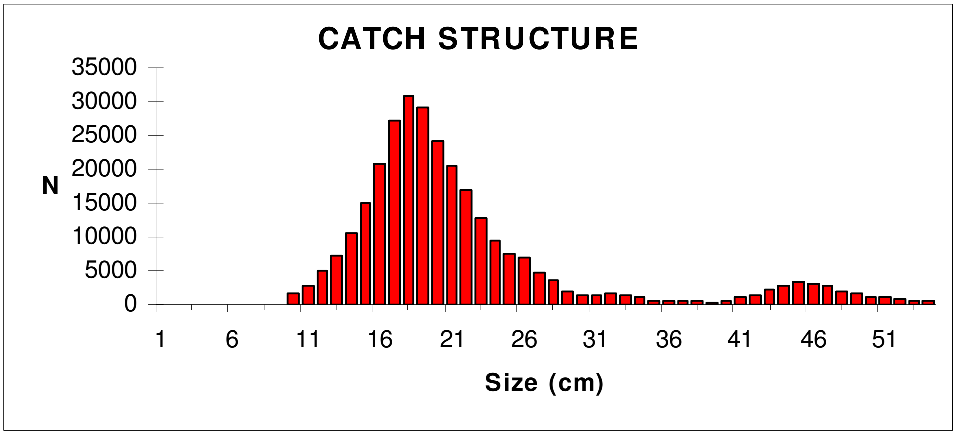


Fig. 6.15.2.3.1 Size structure of commercial catches for trawlers year 2010

6.15.2.3.2 Discards

Percentages and size structure of discards are not well defined. In any case, most of the catch in size and in weight is discarded and almost always only big-sized individuals, longer than 40 cm are landed.

6.15.2.4 Fishing effort

The effort by fishing technique deployed in GSA 09 is requested in the DCR data calls. A minor decrease is observed for the main gear demersal otter trawl and changes in the importance of the effort from the different gears and segments can be observed. It is however difficult to extract from these figures the real number of vessels that target deep sea resources where *Galeus melastomus* is involved.

In the last 15 years, a general decrease in the number of fishing fleets operating with bottom trawl nets in the GSA9 and targeting demersal species was observed. This general reduction did not applied for the vessels targeting *Nephrops norvegicus* for which an increase in the number has been detected, at least in some ports, following an increasing trend of the abundance of the fishery's target species. The number of vessels targeting the species in question and the changes along the time interval 1990-2009 for the port of Viareggio are shown in the next figure.

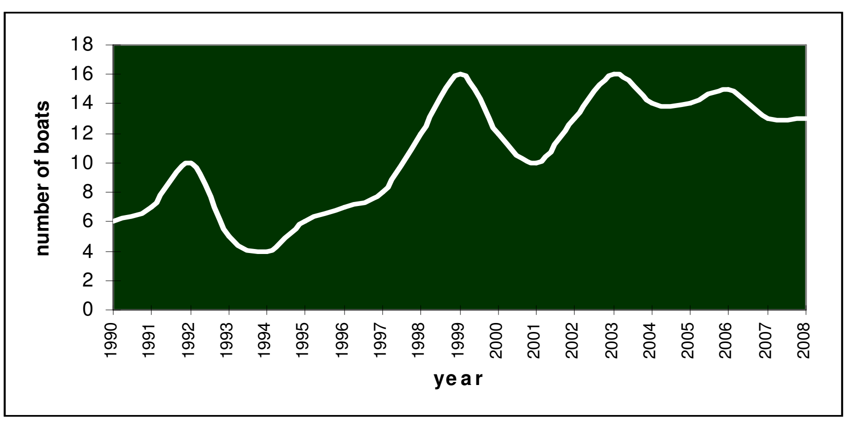


Fig. 6.15.2.4.1 Number of vessels targeting deep sea resources in the port of Viareggio (1990-2008).

6.15.3 Scientific surveys

6.15.3.1 Medits

6.15.3.1.1 Methods

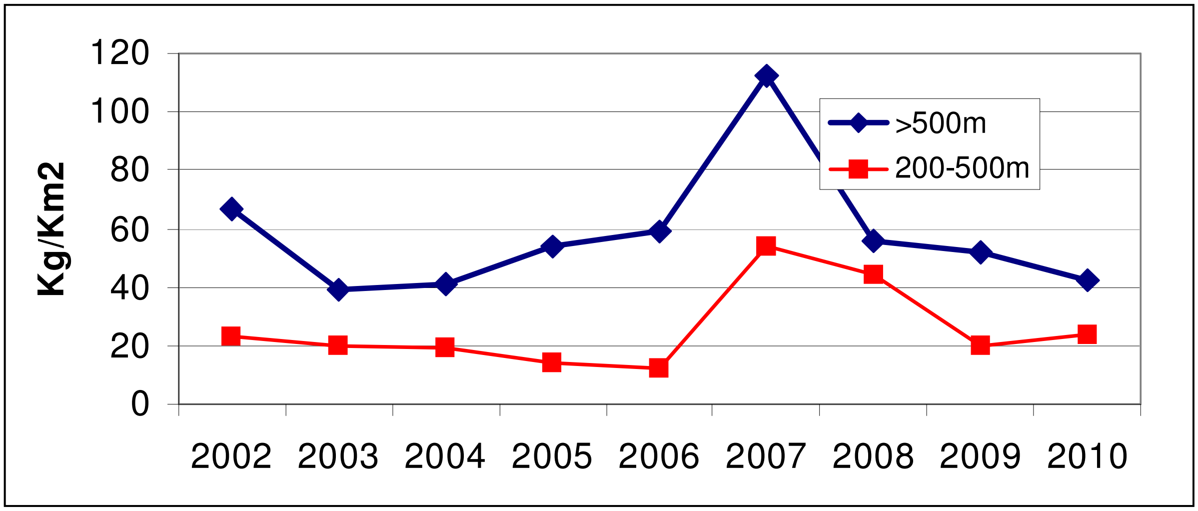


Fig. 6.15.3.1.1.1 Trends in Medits biomass indices by depth strata.

Data were assigned to bathymetric strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes trawling duration. Only hauls considered valid were used in the computations. Valid hauls included the cases of null catches of the species when the net operation was considered as normal.

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). For details on sampling protocol, see Ref. Bertrand (2000)

6.15.3.1.2 Geographical distribution patterns

The species is distributed over the eastern Atlantic from Norway to Senegal and in the Mediterranean Sea. It can be found at depths between 100 and 2000m, but is mainly concentrated in the depth range 200-1200m.

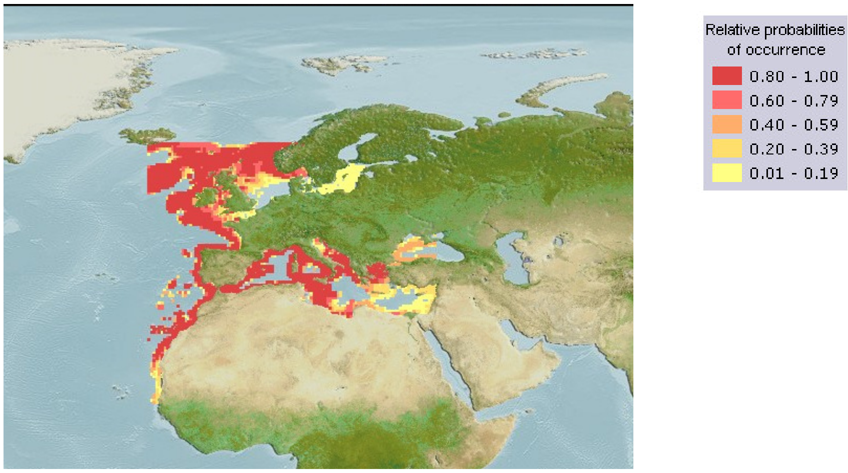


Fig. 6.15.3.1.2.1 Geographic distribution patterns by relative probability of occurrence.

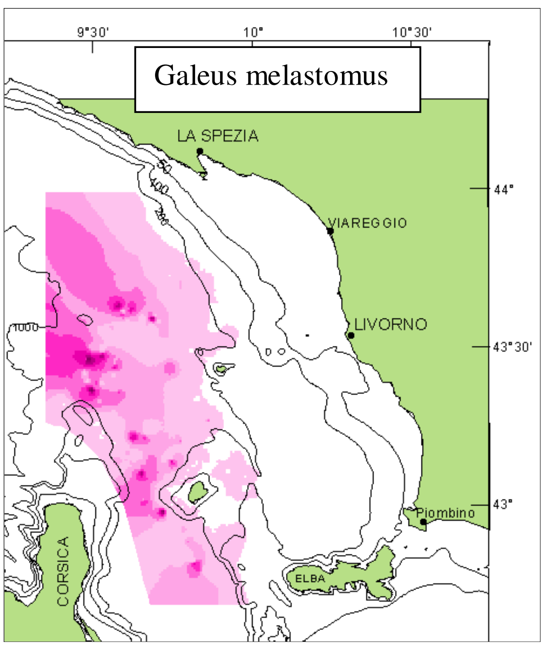


Fig. 6.15.3.1.2.3 Spatial and bathymetric distribution of Galeus melastomus in the northern portion of GSA 09.

Nursery areas, characterized by the presence of young individuals densely concentrated, are found in the depth range 200-400m

6.15.4 Assessment of historic stock parameters

6.15.4.1 Method 1: Length cohort analysis LCA

6.15.4.1.1 Justification

A LCA was performed aimed at the estimation of a vector of *F*-at-size, using data on total annual catches by size for the year 2010, including discards. Considering the availability of only one year of data, it was not possible to perform a formal VPA. The size distribution of the catch for the year 2010 was hence used assuming to be representative of an equilibrium status.

6.15.4.1.2 Input parameters

Official data of blackmouth catshark proceeds from catch data of two fisheries defined by the DCF for Italian waters (bottom trawlers targeting deep sea resources and a not well defined category of mixed fishery.

Tabl. 6.15.4.1.3.1. Size structure of the catch 2010.

size	N	size	N
0		28	3543
1	0	29	1984
2	0	30	1503
3	0	31	1486
4	0	32	1773
5	0	33	1521
6	0	34	1032
7	0	35	474
8	0	36	531
9	0	37	535
10	1804	38	425
11	2794	39	326
12	4949	40	480
13	7094	41	992
14	10627	42	1420
15	15112	43	2274
16	20745	44	2717
17	27173	45	3268
18	30765	46	2918
19	29136	47	2727
20	24304	48	2022
21	20554	49	1655
22	17070	50	1210
23	12675	51	1108
24	9583	52	996
25	7369	53	690
26	7068	54	621
27	4622	55	234

6.15.4.1.3 Results

The length cohort analysis provided a mean *F* of about 0.35. The values of *F* for the older ages may be handled with care due to the limited number of individuals included in the analysis. The largest individuals in general live at deeper waters and are seldom caught.

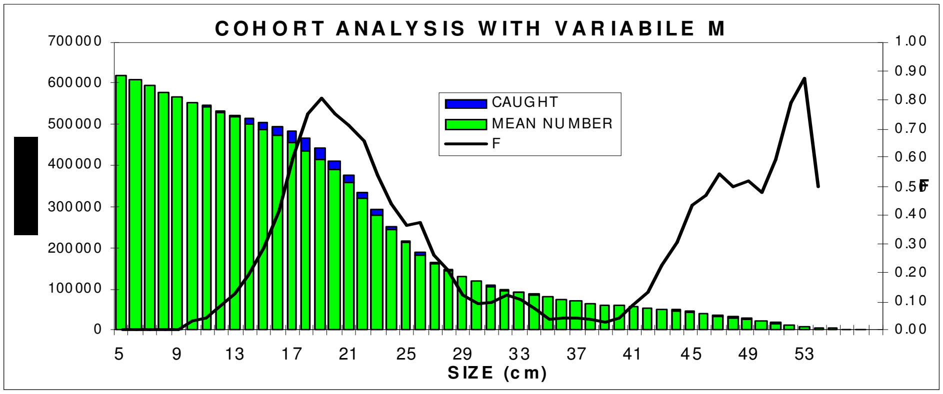


Fig. 6.15.4.1.3.1 Estimated stock size and numbes caught as well fishing mortality F at length.

Tab. 6.15.4.1.3.1 Estimated stock parameters (maturity at age, spawning stock biomass, numbers at age, discards, F vectors, derived from LCA) at age.

	Prop mature	B year	SSB year	total F year	ind W year	N	C OTB land	C OTB dis	F OTB lan	F OTB disc
age										
0	0.0	1124651	0	0	0.2	4057932	0	0	0.00	0.00
1	0.0	16327918	0	0.094668749	4.5	3811847	0	42381	0.00	0.09
2	0.0	34395926	0	0.669124446	18.2	1980318	0	169748	0.00	0.67
3	0.0	26989128	0	0.394147657	41.8	657818	0	41316	0.00	0.39
4	0.0	30841478	0	0.127478777	75.0	429485	0	10290	0.00	0.13
5	0.0	28206394	0	0.263408346	115.1	256902	1720	1838	0.13	0.14
6	0.9	30769074	0	0.035118687	159	201208	1274.02095	492	0.03	0.01
7	1.0	23228457	23228457	0.147909471	200	116771	4685.24105	0	0.15	0.00
8	1.0	18899539	18899539	0.40216856	246.5	77459.5	8902.46768	0	0.40	0.00
9	1.0	8338661	8338661	0.518934563	189	28926.3	4748.80272	0	0.52	0.00
10	1.0	5366028	5366028	0.496056803	327	16438.4	2864.88511	0	0.50	0.00
11	1.0	3182328	3182328	0.69024561	370	8657.51	2104	0	0.69	0.00
12	1.0	874218.3	874218.3	0.874338224	400	2169.54	690	0	0.87	0.00
13	1.0	529530.2	529530.2	0.5	430	1242	621	0	0.50	0.00
14	1.0				445		0	0	0	0.00
15	1.0				485		0	0	0	0.00

6.15.4.2 Method 2: Demographic analysis with a Leslie matrix

6.15.4.2.1 Justification

A demographic analysis was used for the definition of the status of the stock regarding its capacity of self-renewal (Caswell, 1989).

For this stock, data required to support a complete and more robust traditional analytic stock assessment models does not exist. As a complementary it was performed analysis a demographic model that rely primarily on life history parameters. Such analysis is expected to provide some useful information for management. The approaches based on life history traits as fecundity and survival rates are widely used for modelling population dynamics in elasmobranches (Hoenig and Gruber, 1990; Cailliet, 1992; Cortes and Parsons, 1996; Cortes, 1999, 2002; Smith et al, 1998; Simpfendorfer, 1999; Mollet and Cailliet, 2002).

Life tables (as well as Leslie matrices) are based on the Euler-Lotka equation, and needs of the definition of the survival at age, fecundity at age (female pups per female), age at maturity, and maximum reproductive age. They keeps track of the age-specific mortality and reproductive rates, and allows estimating *r* that measures the potential for growth in a population.

The main information needed regards lifespan, age at maturity, fecundity by age/size and sex ratio. The basic equation is the Euler-Lotka :

$$\sum_{t=0}^{w} l_t \times m_t \times e^{-rt} = 1$$

where l_t is the proportion of animals surviving to the beginning of a given age class, m_t the age specific natality, w is the maximum reproductive age, t=age and r is the intrinsic population growth rate.

It is necessary to estimate the finite or annual rate of change (e^r) from the estimated values of r.

Using simple life tables, the net reproductive rate R_0 is the offspring number of an individual female belonging to a certain age $t \geq \alpha$ and can be calculated as

$$R_0 = \sum_{t=\alpha}^{w} l_t \times m_t$$

while the mean generation lenght (G) is the average time that occur between the birth of a parent and the birth of their offspring:

$$G = \frac{\sum_{t=\alpha}^{w} l_t \times m_t \times t}{R_0}$$

The doubling time of population size can be calculated as:

$$T_{\times 2} = \frac{\ln(2)}{r}$$

and the stable proportion of each age P_t in the total demographic distribution of the population can be estimated as follows:

$$P_t = \frac{(e^r)^t l_t}{\sum_{t=o}^{w} (e^r)^t l_t}$$

It is also possible to estimate the intrinsic capacity for increase despite of the particular condition of the environment r_m and following the well-known Verlhust-Pearl population growth model as:

$$r_m = \frac{\ln(R_0)}{G}$$

The method does not include the likely compensatory effects to fishing pressure as reduction in natural mortality, increase in reproductive rates, earlier age of first maturity, etc.

Age specific survival values, that in the former studies using life tables were based only on natural mortality, can be easily modified by including fishing effects by using total mortality rates Z for the estimation of survival.

In alternative, but obtaining almost identical results, age-structured matrix models, in particular the Leslie matrices, are now more frequently used in the assessment of shark populations. (i.e. Hoenig and Gruber,1990). The use of a Leslie Matrix allows estimating λ . The value of λ is found by searching for the dominant eigenvalue of the matrix by using matrix algebra.

This matrix was analyzed using Poptools. It is a versatile add-in for PC versions of Microsoft Excel (97, 2000 or XP) that facilitates the analysis of matrix population models and simulation of stochastic processes.

The Leslie Matrix was adapted to include information on fishing mortality at specific ages, or changes in the reproductive schedule. Poptools shows a list of all the eigenvalues of the projection matrix. The dominant eigenvalue give the stable age structure and reproductive values. They are "normalised" to one (100%). It also lists the rate of increase and the generation time.

In order to assess how much influence the changes in the used estimates of the vital rates fecundity at age and mortality rates have on the population growth rate, the software allows the performance of sensitivity analyses. In this case, such sensitivity analysis is reported as the elasticity, which is the proportional (relative) change of sensitivity. This choice facilitates the comparisons related to the consequences (impact on the estimates of population growth rate) of small changes in fecundity and on the mortality rates, which are obviously expressed in different absolute scales. Elasticity is calculated from the elements of the transition matrix , the population growth rate (r) and the elements of the right and left eigenvectors.

Elasticity allows identifying the ages at which smallest changes in vital rates can produce biggest changes in the population growth rate. Elasticity analysis allows defining the management choices likely to produce more benefits to the stock, by estimating how much vulnerable is the species to changes in the survival of the juveniles (or for the adults) depending on the characteristics of the species in question (small or large, slow or fast-growing, long or short-lived species).

6.15.4.2.2 Input parameters

The input parameters are natural mortality rate M, fecundity at age, age of maturity, as defined above.

6.15.4.2.3 Results

The results of the demographic analysis suggest that the current combination of exploitation pattern and level of F do not guarantee sustainability for the stock, which is characterized by a low fecundity and relatively late age of sexual maturity (6 years old). A fishing mortality of about 0.08 can be considered the limit in order to guarantee the self-renewal fishing with the current pattern (Lc=<1yr).

It was calculated a value related to *r* (the innate capacity for increase under particular conditions (r_m) (Krebs,1985).

Tab. 6.15.4.2.3.1 Results of the model applied.

Eigenvalues		Eigenvectors (R&L)		
Real	Imaginary	Age/stage struct	Reprod val	
1.19258562	0		42.7%	0.2%
0.458223607	-1.005010095		29.3%	0.3%
0.458223607	1.005010095		16.5%	0.6%
0.028186075	-0.086890538		7.6%	1.4%
0.028186075	0.086890538		2.9%	3.6%
-0.005975042	-0.15739413		0.9%	5.1%
-0.005975042	0.15739413		0.2%	6.7%
-0.028112363	0.270238358		0.0%	7.9%
-0.028112363	-0.270238358		0.0%	8.7%
-0.074649539	-0.106387218		0.0%	9.2%
-0.074649539	0.106387218		0.0%	9.8%
-0.138219898	0		0.0%	9.6%
-0.162856646	0.089466371		0.0%	9.4%
-0.162856646	-0.089466371		0.0%	9.3%
-0.741998952	0.616611554		0.0%	9.2%
-0.741998952	-0.616611554		0.0%	8.9%
r	0.17612374	(rate of increase)		
Ro	2.726377308	(expected number of replacements)		
T	5.694710629	(generation time - time for increase of Ro)		
mu1	5.767271949	(mean age of parents of offspring of a cohor		
N (fundamental matrix)				

The dominant eigenvalue (λ) was 1.193 (r = Lnλ = 0.176/year) , and the mean age of parents of the offspring of a cohort of 5.77 years

The generation time *G* corresponding to the weighted mean age of spawners in a not exploited population (Goodyear 1995) was estimated to be 5.69 years assuming a mean M=0.2

Results suggest a relatively slow rate of increase of the population and turnover, which is consistent with a species characterized by a relatively slow individual growth, late age of maturity and low fecundity.

While the Leslie matrix was modified for allowing the inclusion of fishing mortality rates and changes in age of first capture, this allowed the estimation of the values of the rate of population growth r_m obtained with different combinations of age of first capture Lc and fishing mortality rate F. In the figure, the green area represents combinations that define a positive value for r_m.

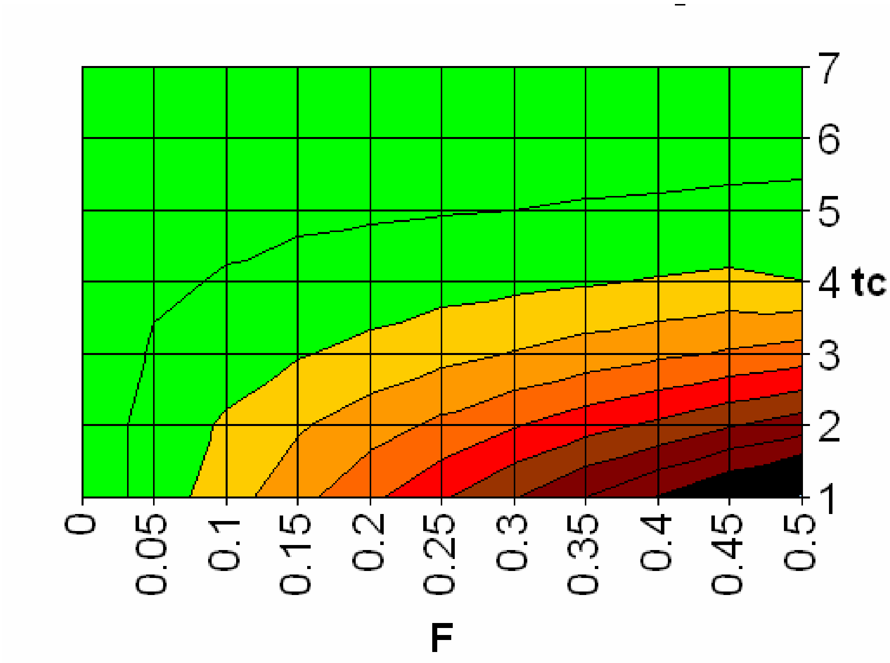


Fig. 6.15.4.2.3.1 Isoplets of the rate of population growth r_m obtained with different combinations of age of first capture Lc and fishing mortality rate F. The green area represents combinations that define a positive value for r_m.

Tab. 6.15.4.2.3.2 Values of the intrinsic rate of population growth r_m obtained with different combinations of age of first capture *Lc* and fishing mortality rate *F*.

	age first capture						
F	1	2	3	4	5	6	7
0.00	0.176	0.176	0.176	0.176	0.176	0.176	0.176
0.05	0.058	0.059	0.090	0.114	0.136	0.133	0.135
0.10	-0.055	-0.014	0.049	0.094	0.120	0.130	0.134
0.15	-0.167	-0.086	0.008	0.075	0.115	0.129	0.133
0.20	-0.277	-0.156	-0.030	0.060	0.110	0.128	0.133
0.25	-0.386	-0.220	-0.070	0.041	0.105	0.125	0.133
0.30	-0.494	-0.290	-0.105	0.024	0.100	0.124	0.133
0.35	-0.600	-0.360	-0.140	0.009	0.096	0.123	0.133
0.40	-0.705	-0.420	-0.177	-0.006	0.093	0.123	0.133
0.45	-0.810	-0.490	-0.210	-0.020	0.088	0.122	0.132
0.50	-0.910	-0.550	-0.245	-0.003	0.085	0.120	0.132

The net reproductive rate (R0) is the total number of female offspring produced per individual in a single cohort:

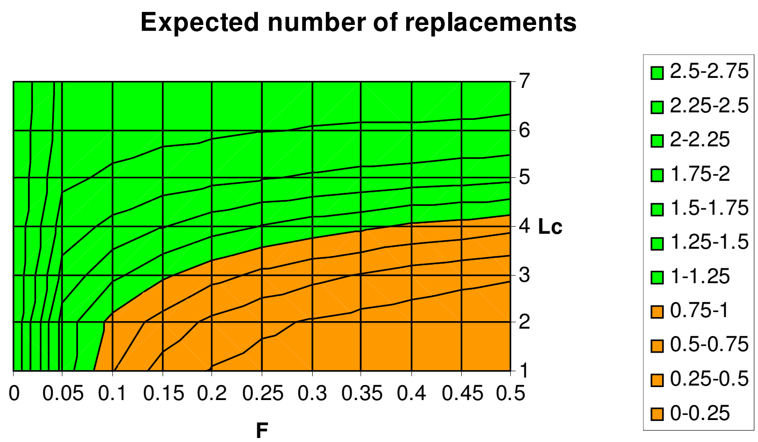


Fig. 6.15.4.2.3.2 Expected number of replacements per female at different combinations of F and tc.

The mortality rate that is considered as a limit in order to avoid a reduction of the populations (*F*c) derived from the demographic analysis for the current exploitation pattern was *F*=0.08

The use of the elasticity analysis made possible to estimate how much vulnerable to changes in the survival of the juveniles (or the adults) depending on the characteristics of the species in question (small or large, slow or fast-growing, long or short-lived species. The results, that allowed a comparison among the consequences (sensitivity) to small changes in fecundity and on the mortality rates, derive from standardized information, considering that data are originally expressed in different absolute scales. The higher elasticity values are highlighted in a scale of red.

Tab. 6.15.4.2.3.3 Results of the model

	1	2	3	4	5	6	7	8	9	10	11	12
	0	0	0	0	0.1004	0.0522	0.0192	0.005	0.001	0.0001	2E-05	2E-06
	0.1779	0	0	0	0	0	0	0	0	0	0	0
	0	0.1779	0	0	0	0	0	0	0	0	0	0
SURVIVAL	0	0	0.1779	0	0	0	0	0	0	0	0	0
	0	0	0	0.1779	0	0	0	0	0	0	0	0
	0	0	0	0	0.0775	0	0	0	0	0	0	0
	0	0	0	0	0	0.0254	0	0	0	0	0	0
	0	0	0	0	0	0	0.0062	0	0	0	0	0
	0	0	0	0	0	0	0	0.0011	0	0	0	0
	0	0	0	0	0	0	0	0	0.0002	0	0	0
	0	0	0	0	0	0	0	0	0	2E-05	0	0
	0	0	0	0	0	0	0	0	0	0	2E-06	0
	0	0	0	0	0	0	0	0	0	0	0	1E-07
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0

Results of the elasticity analysis comparing the consequences (sensitivity) of small changes in fecundity and on the mortality rates, standardized considering that they are originally expressed in different absolute scales. The higher elasticity values are highlighted in a scale of red. The higher values are found in the survival at age cells, suggesting that is in the first ages where smallest changes in vital rates can produce biggest changes in the population growth rate

The higher values are found in the survival at age cells, suggesting that is in the first ages where smallest changes in vital rates are likely to produce biggest changes in the population growth rate. For *Galeus melastomus* the analysis suggests that management measures aimed at protecting juveniles (e.g., mesh size increase, nursery area closures) should provide greater benefits to the population than a strategy aimed at protecting adults.

The current F was estimated as 0.35 with a value of $F_{0.1}$ estimated was F=0.13, The demographic analyses (growth rates at different combinations of F and tc and elasticity) have shown that the achievement of such goals might be facilitated by an increase of the age of entry to the fishery of the species.

6.15.5 Long term prediction

6.15.5.1 Justification

The Y/R analysis allowed to estimate the expected relative yields and surviving fraction of the parental biomass at different mortality rates and to produce an estimate of $F_{0.1,}$, which can be considered a proxy of F_{MSY}.

The age-based Yield per Recruit (YpR) routine, included in the stock assessment toolbox of NOAA was used. It is based on the Thompson-Bell model for estimating the expected lifetime yield and biomass from a cohort subjected to varying levels of fishing mortality.

The present version incorporates estimates of life-history parameters such as mean age, mean generation time, reproductive value, expected number of spawnings, reproductive output from first-, second- and multiple time spawners.

6.15.5.2 Input parameters

The input parameters (growth parameters, M, Length/weight relationship) are those defined above.

6.15.5.3 Results

The Y/R analysis produced an estimate of $F_{0.1}$ = 0.13 considered a proxy of F_{MSY}

The main results related to some reference values of mortality rates are reported in the table below.

Tab. 6.15.5.3.1 Result of the YpR analysis.

Reference Point Summary Table

Reference Point	F	Yield per Recruit	SSB per Recruit	Total Biomass per Recruit
F Zero	0.00000	0.00000	157286.72604	239593.70248
F-01	0.13000	11384.41293	48843.30212	103172.63998
F-Max	0.18000	11731.46664	31924.86827	78697.92348
F at 40 % MSP	0.10000	10598.43334	63434.15284	123033.18089

Fig. 6.15.5.3.1 Result of the YpR analysis.

6.15.6 Scientific advice

6.15.6.1 Short term considerations

6.15.6.1.1 State of stock size

The status of the assessment and data does not allow any conclusions. In the absence of a precautionary reference point, STECF EWG 11-12 is unable to fully evaluate the stock size status.

6.15.6.1.2 State of recruitment

The status of the assessment and data does not allow any conclusions.

6.15.6.1.3 State of exploitation

The STECF EWG-11-12 proposes F0.1=0.13 (Fmsy proxy) as limit reference point consistent with high long term yield and low risk of fisheries collapse. Sonsidering the current estimate of fishing mortality rate of F=0.35 the STECF EWG classifies the stock status as being subject to overfishing.

The size of first capture is too low (growth overfishing) and an increase in yield and a more safe situation for the stock as regards the possibility of self-renewal can be expected in the case a reduction of fishing effort do occur and/or more selective gears are used. Therefore, EWG raccomends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

6.16 Stock assessment of anchovy in GSA 09

6.16.1 Stock identification and biological features

6.16.1.1 Stock Identification

Due to a lack of information about the structure of anchovy population in the western Mediterranean, this stock was assumed to be confined within the GSA 09 boundaries. Studies are needed on the biological stock identification of this species in the Mediterranean.

The spawning season of the species in the area is in spring-summer. The maximum age recorded was 5 years while the maximum length was 17.5 cm TL.

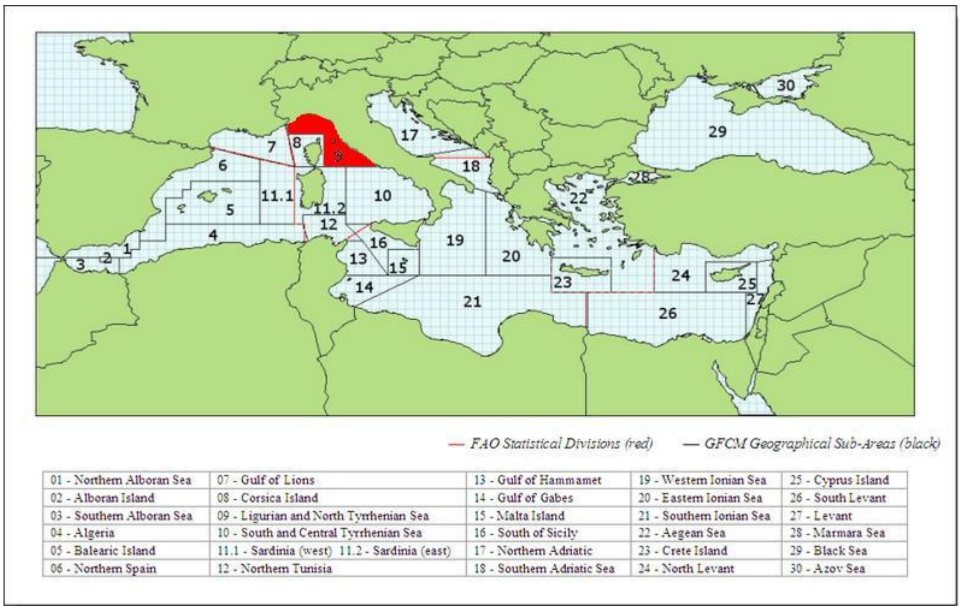


Fig. 6.16.1.1.1 Stock distribution map.

6.16.1.2 Growth

Growth parameters were estimated using data collected in the framework of the DCF. The method applied was the Von Bertalanffy equation fit to the age (otolith readings) and growth data using non-linear estimation with minimum least squares. An example of age-length key expressed in number of individuals, obtained through DCF for the commercial catches of purse seiners in 2008, was reported in Tab 6.16.1.2.1.

Tab 6.16.1.2.1 GSA 9 anchovy: age-length key (year 2008, purse seiners).

	Age group				
TL (cm)	0	1	2	3+	Total
10.5	9				9
11.0	30	26			56
11.5	11	250			261
12.0		621			621
12.5		650	84		734
13.0		688	220		908
13.5		482	432		914
14.0		217	766	6	989
14.5		102	642	24	768
15.0		6	518	59	583
15.5			286	103	389
16.0			155	79	234
16.5			41	44	85
17.0			5	8	13
17.5				2	2
Total	50	3042	3149	325	6566

6.16.1.3 Maturity

The first sexual maturity for female anchovy in the GSA 9, estimated using collected in the framework of DCF, is around 11.6 cm TL.

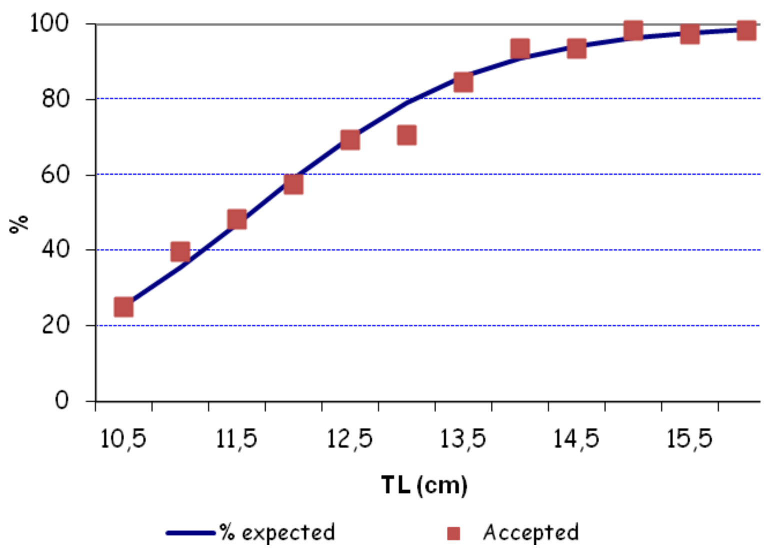


Fig. 6.16.1.3.1 GSA 09 anchovy: size at first maturity.

6.16.2 Fisheries

6.16.2.1 General description of the fisheries

In the GSA 09, anchovy is mainly exploited by purse seiners that use light for attracting fish. Due to the high economic value, anchovy represents the target species for this fleet in the GSA 09, while sardine (*Sardina pilchardus*) is the other important species exploited by this fishery. The fishing season starts in spring (March) and ends in autumn (October). Favorable weather conditions and abundance in the catches can extend the fishing activity to the end of November. However, the maximum activity of the fleet is normally observed in summer. Some vessels coming from the south of Italy (mainly from GSA 10) join the local fleet. Anchovy is also a by-catch in the bottom trawl and gillnet fisheries; however, the landings done by these *metiers* are very low (about 5%) in comparison to those by purse seiners. Pelagic trawling is not carried out in the GSA 09.

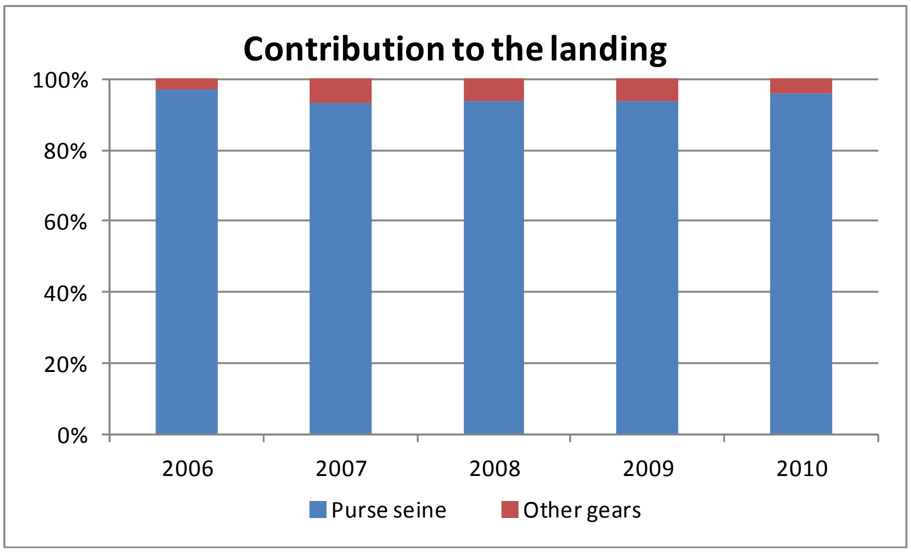


Fig. 6.16.2.1.1 GSA 09 anchovy: Contribution of the different fleets to the total landing in the period 2006-2010.

6.16.2.2 Management regulations applicable in 2010 and 2011

In Italy, the legal minimum length for anchovy is 9 cm (R. (CE) 1967/2006). 14 mm is the minimum mesh size allowed for purse seine and 40 mm squared or 50 mm diamond cod end mesh size for bottom trawl.

6.16.2.3 Catches

6.16.2.3.1 Landings

The annual amount of the total catch of anchovy reported by the Italian national statistics for GSA 09 is plotted in Fig. 6.16.2.3.1.1. An increasing trend is observed from 1961 to 1986 with two evident peaks in 1976 and 1986. Then, a strong decrease occurred, with minimum values registered in 1991-92. In the last 20 years the landings resulted notably lower than those observed in the previous period, with very low values in 2004 and 2005. A positive trend is observed in the last two years.

A comparison between the landings data and the MEDITS biomass indeces (kg/km^2) for the period 1994-2010 showed a significant correspondence of the two trends. This fact could be considered as a sort of cross-validation of the two data series recognizing MEDITS as a possible indicator of the trend of the biomass also *for small pelagic species* like anchovy. In the GSA 09 specific studies on the abundance of small pelagic species started in 2009 applying MEDIAS survey methodology.

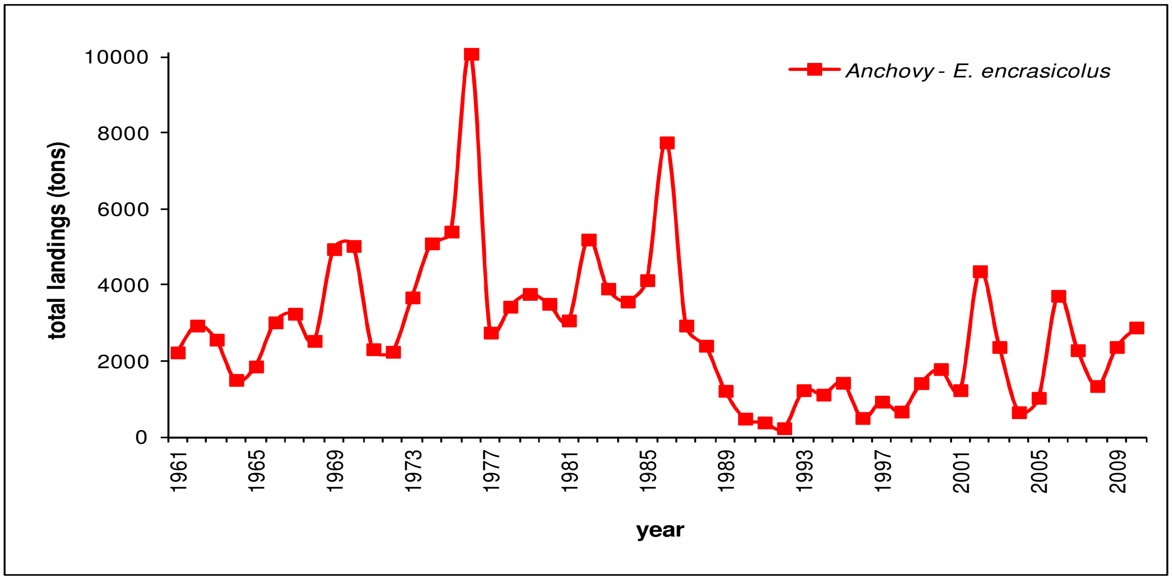


Fig. 6.16.2.3.1.1 GSA 9 anchovy: total catch over years.

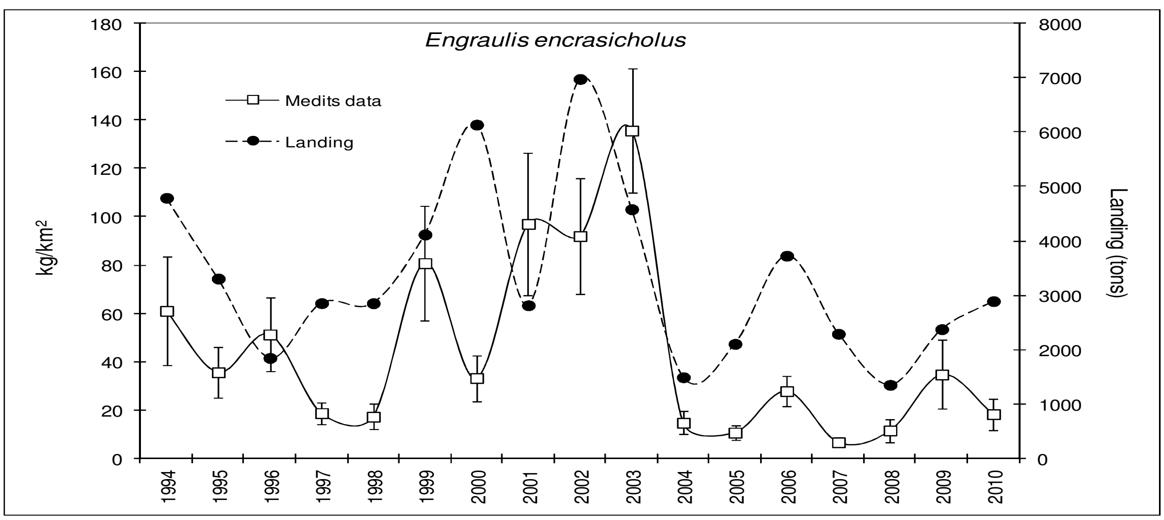


Fig. 6.16.2.3.1.2 GSA 09 anchovy: comparison of the total landing with the MEDITS biomass indices for the period 1994-2010.

Data on size and age composition of the landing in the GSA 09 are available for the period 2006-2010. The length frequency distribution and the age frequency distribution of total landings (purse seine + other gears) are shown in Figures 6.16.2.3.1.3. and 6.16.2.3.1.4. In both cases, the distribution observed in 2007 resulted quite different from the other years. In 2007 the modal class was at 11.5 cm TL, corresponding to the specimens in the first age class (0+). In the case of 2006, 2009 and 2010 the modal class was quite similar

(12-13 cm), while in 2008 the most represented is 14 cm TL; with the exception of 2008, the main important age class was the 1.

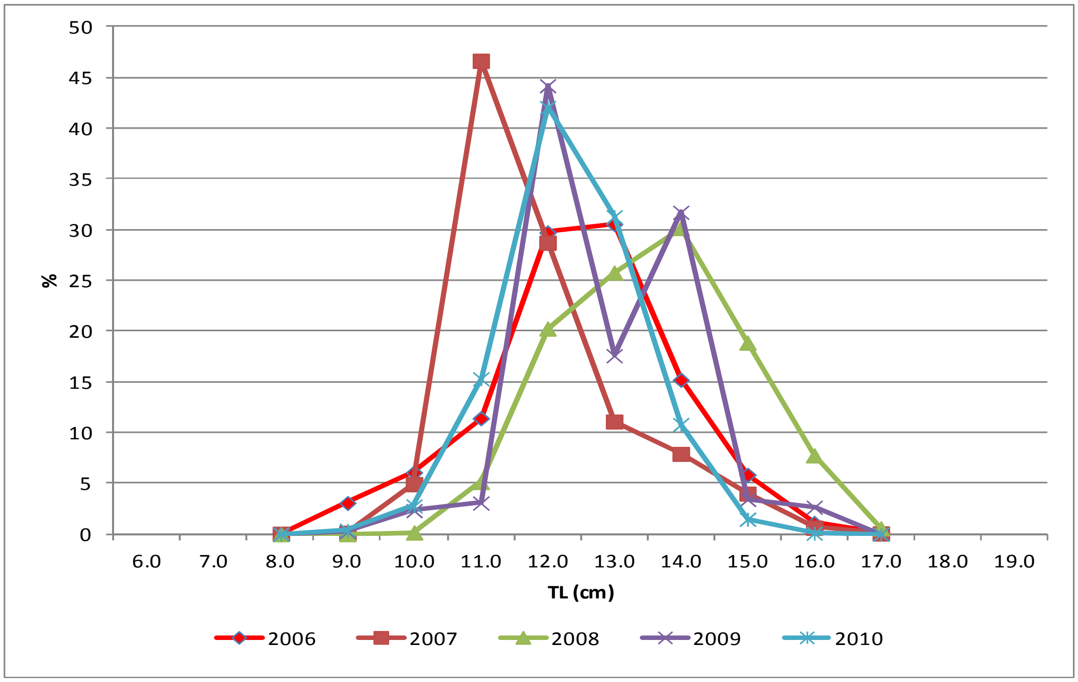


Fig. 6.16.2.3.1.3 GSA 09 anchovy: annual length frequency distribution of the total landing.

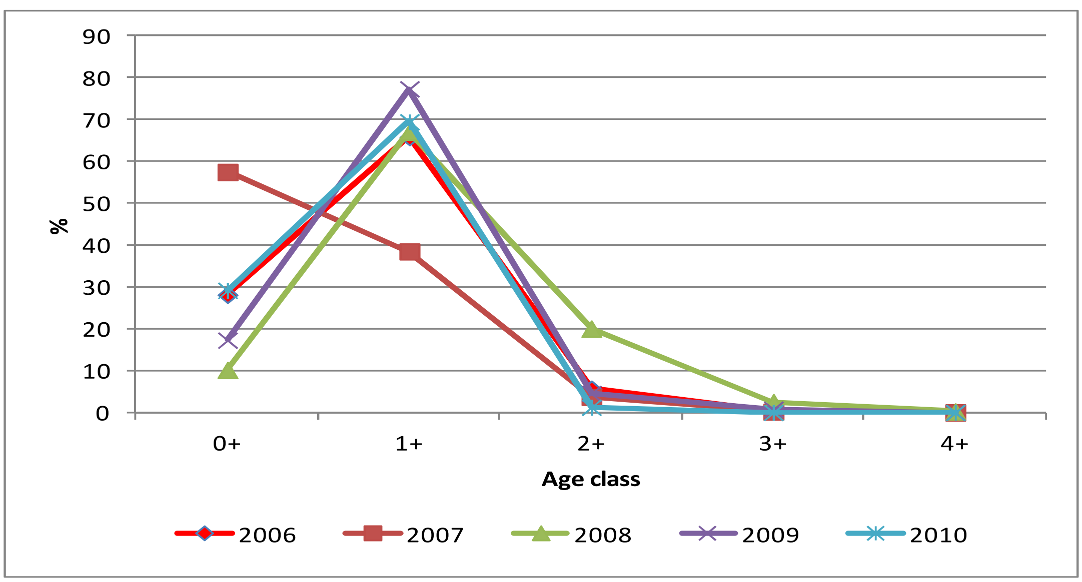


Fig. 6.16.2.3.1.4 GSA 09 anchovy: annual age frequency distribution of the total landing.

Tab. 6.16.2.3.1.1 Landings (t) as officially submitted through the DCF data call.

FT_LVL4	FT_LVL5	2004	2005	2006	2007	2008	2009	2010
GNS	DEMSP	2	25	13	16	18	4	6
GNS	SLPF		2			4	2	3
OTB	DEMSP	26	2	3	15	81	119	62
OTB	MDDWSP	33	118	78	69	10	2	38
PS	SPF	1432	1956	3630	2193	1240	2379	2893

6.16.2.3.2 Discards

Studies carried out in the framework of the DCF in 2005 demonstrated that discards of anchovy for the Italian fleet can be considered as negligible, because anchovy is usually strongly required by the market. According to the DCF investigation, the discards at sea of anchovy in the Adriatic Sea amounted 65 t and 206 t in the third and fourth quarter of 2005, respectively. These quantities were very low in comparison with the corresponding landings, 20,000 t on average per year in the period 2000-2007. The estimates of discards obtained for one half of 2005 was considered negligible and have been not included in the estimation of total catches.

6.16.2.4 Fishing effort

The fishing capacity of the purse seine fleet in the GSA 09 showed in last 10 years a progressive increase in the period 2002-2004, passing from about 33-35 to 52 vessels. Then, the number of vessels remained quite constant over time. No information is available for 2010.

The activity mainly ranged between 4,500 and 5,200 fishing days per year, with maximum value in 2004 (7,256) and minimum in 2008 (3,911). The fishing effort, expressed as GT · fishing days, is available for the period 2004-2010. The data show an evident decreasing trend with minimum value in 2008. A higher value was observed in 2009.

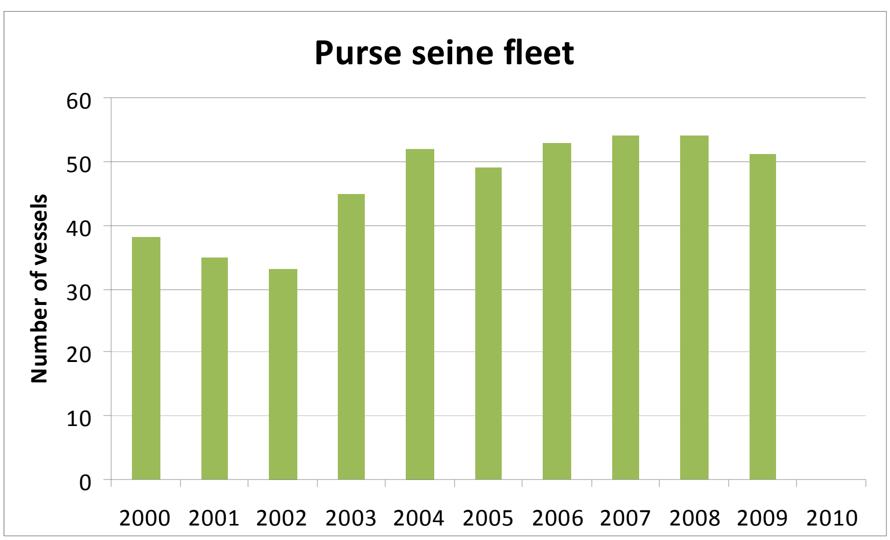


Fig. 6.16.2.4.1 GSA 09: Number of purse seine vessels for the period 2000-2010.

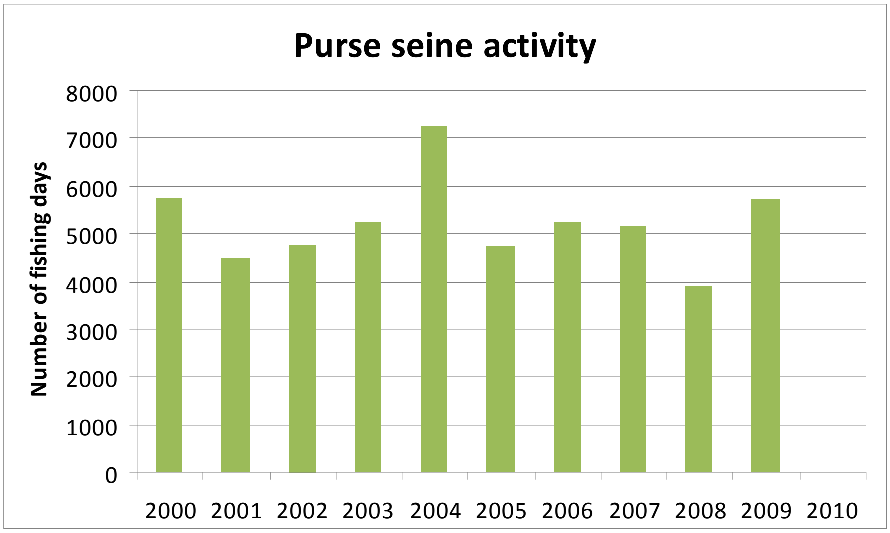


Fig. 6.16.2.3.3.2 GSA 09: Number of purse seine fishing days per year.

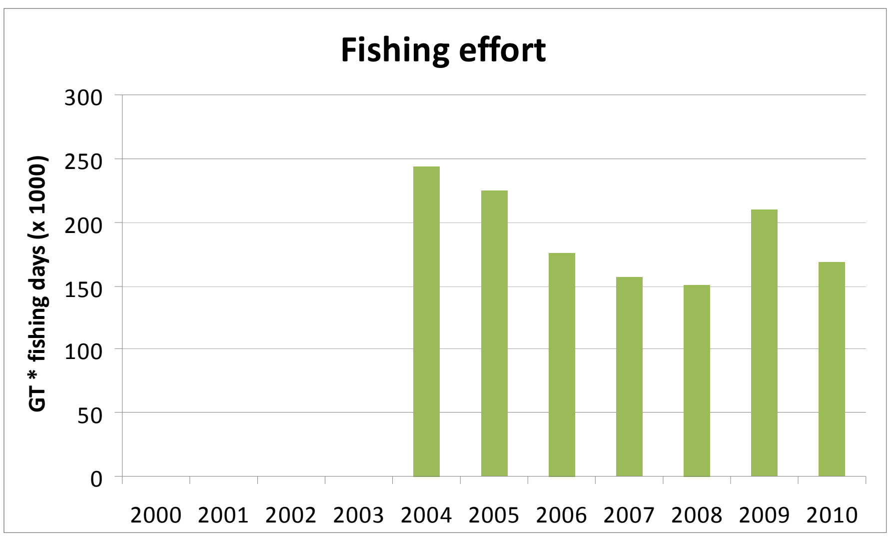


Fig. 6.16.2.3.3.3 GSA 09: total fishing effort (GT * fishing days) of purse seine vessels.

Tab. 6.16.2.3.3.1 Nominal effort (kW*days at sea) as submitted through the DCF data call.

AREA	FT_LVL4	FT_LVL5	2004	2005	2006	2007	2008	2009	2010
SA 9	-1	-1	625573	687167	315913	94352	157604	257740	210796
SA 9	-1	DEMSP	833802	896537	623504	541459	363494	357492	101535
SA 9	-1	FINF	37899						
SA 9	DRB	MOL	271337	264317	219582	230204	381592	277250	231746
SA 9	FPO	DEMSP			1664		25059	9493	9710
SA 9	GND	SPF	15372	4992	62253			4431	17144
SA 9	GNS	DEMSP	3734910	3780691	3244878	3678470	3000868	3151600	2548415
SA 9	GNS	SLPF	23408	122032	15803	77127	54077	64941	93091
SA 9	GTR	DEMSP	3281736	3814641	3861674	2760530	2403569	2948897	2719155
SA 9	LLD	LPF	510386	821542	927993	507078	585762	358051	434722
SA 9	LLS	DEMF	433999	495263	383076	112305	31287	31260	20003
SA 9	LTL	LPF			6987	2421		2603	
SA 9	OTB	DEMSP	6502587	1990472	2972712	4376403	8357124	9535704	7687942
SA 9	OTB	DWSP	40824				224937	502844	695877
SA 9	OTB	MDDWSP	8280673	12710127	9432075	8404088	2567330	2069104	2907279
SA 9	PS	LPF	29100	14273		1254	67650	39051	4442
SA 9	PS	SPF	1395238	1412031	1146586	1115325	950335	1244914	916543
SA 9	PTB	SPF			4599				

6.16.3 Scientific surveys

As mentioned above, in GSA 09 acoustic survey for the estimation of small pelagic species started in 2009. In the future, the data collected through this eco-survey will be utilized for tuning the VPA.

6.16.4 Assessment of historic stock parameters

6.16.4.1 Method: LCA on DCF data

6.16.4.1.1 Justification

Assessment was performed using an LCA (VIT software, Lleonart and Salat 1997) on an annual pseudo-cohort. Data coming from DCR provided at EWG-11-12 contained, for GSA 09, information on anchovy landings and the respective purse seine size/age structure for the years 2006-2010. The size distribution for purse seine has been expanded also to the landing of other gears as no information on demographic structure is available for them. LCA was performed using VIT software on data of the years 2009 and 2010 applying the same methodology and set of parameters used for the assessments done on 2006-2008 data carried out during the SGMED-10-2 working group.

6.16.4.1.2 Input parameters

Tab. 6.16.4.1.2.1. Input demographic data for LCA of anchovy in GSA 09.

TL (cm)	2006	2007	2008	2009	2010
8.0	47720	46469	0	31054	21307
9.0	7469814	203295	0	388178	774367
10.0	14803968	7393404	95325	3366300	5636931
11.0	27777284	70034331	2976463	4462868	30960049
12.0	72305121	43123793	11752399	64265365	85019870
13.0	74314291	16667855	14945013	25571718	63281872
14.0	36988347	11874520	17494655	46121249	21852921
15.0	14223716	5990713	10947072	4974421	2977397
16.0	2672593	955299	4503855	3851977	174646
17.0	144456	107794	332578	46356	0

The following set of parameters was used:

Growth parameters (Von Bertalanffy)
$L\infty$ = 186 (mm, length)
K = 0.6
to = - 0.80
L*W
a = 0.006
b = 3.081
Natural mortality
M vector Age_1=1.32 , Age_2=0.52, Age_3=0.40, Age_4=0.35, Age_5=0.35
q(age 1+) = 1.0, q(age 2+) = 1.0, q(age 3+)= 1.0, q(age 4+)= 1.0, q(age 5+)= 1.0
Length at maturity (L_{50})
L_{50} = 11.6 cm

The vector of natural mortality M was estimated using the software Prodbiom.

6.16.4.1.3 Results

The general results of LCA highlight an exploitation focused on young age classes, mainly 0+ and 1. Some differences were found comparing the results obtained for 2007 in respect to the other four years. In 2007 the exploitation was mainly directed on the first age class. This pattern is not the consequence of a change in the exploitation pattern by the fleet but probably is more related to the higher abundance of juvenile anchovy during that year. Anchovy is a typical small pelagic species with high recruitment fluctuation from one year to another.

For the F value per age class, a similar pattern has been observed for the first three years, with higher values for the age classes 1 and 2. In 2009, F showed a high value also on the 3 age class, while in 2010 the fishing mortality was mainly concentrated on the 1 age class.

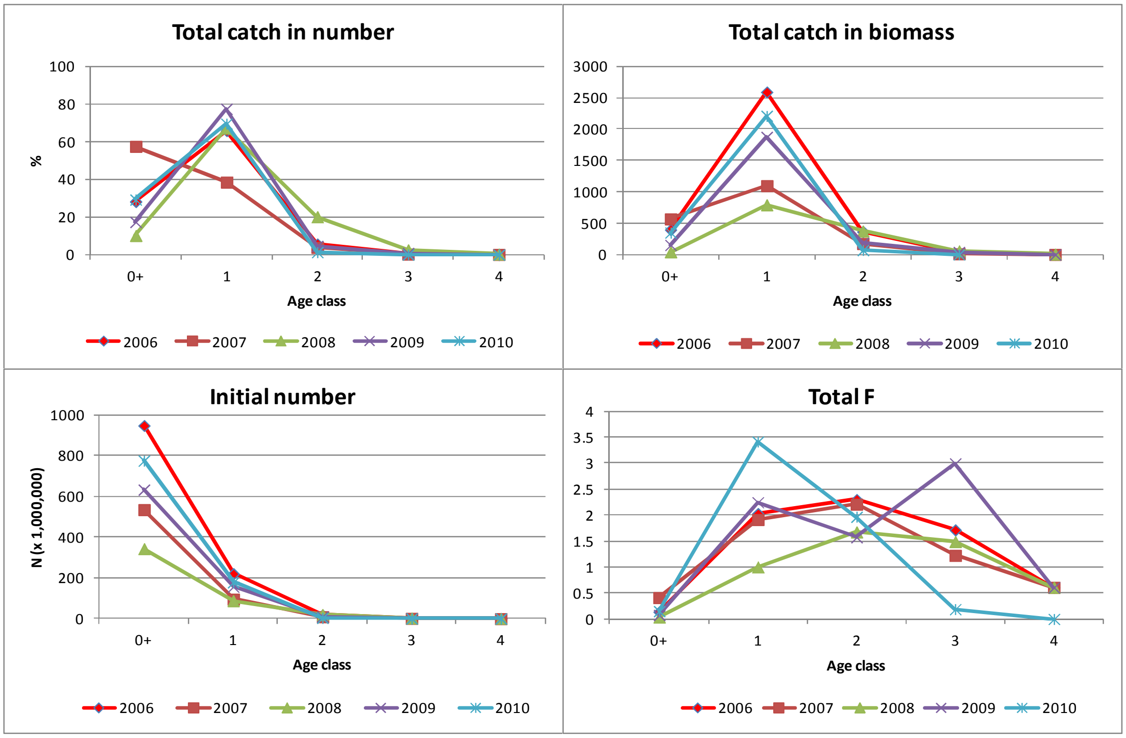


Fig. 6.16.4.1.3.1. LCA outputs: catch numbers, numbers-at-age, initial number and fishing mortality at age of anchovy in the GSA 09.

The mean fishing mortality, computed excluding the first age class, as it is not fully exploited by the fleet, shows high values with a tendency to the reduction over time from 2006 to 2008. The correspondent exploitation rates resulted quite constant with slightly higher value in the last year. The annual exploitation rates were very high when compared with the reference value of 0.4 suggested by SGMED for small pelagic species.

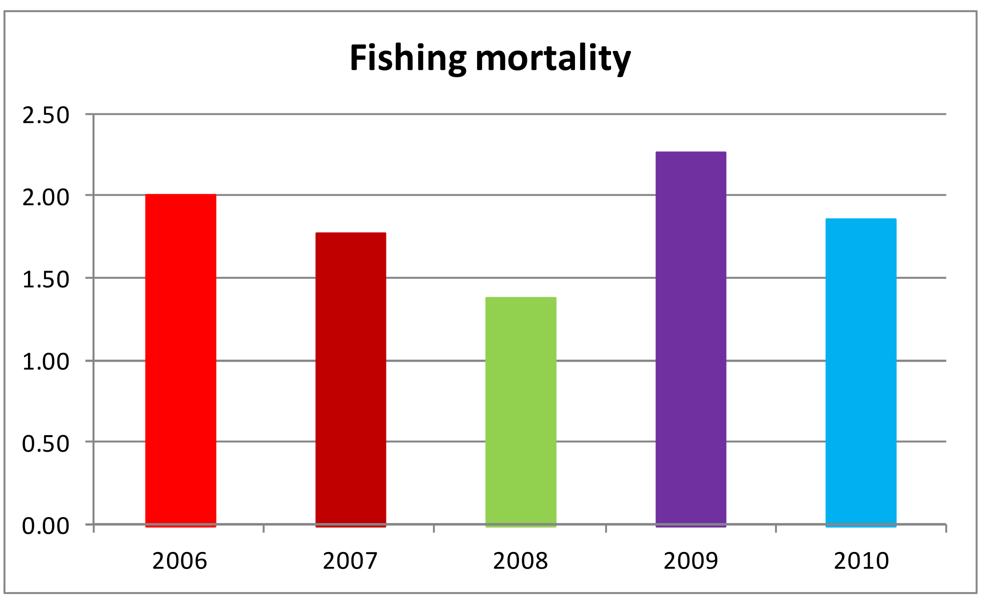


Fig. 6.16.4.1.3.2. LCA outputs: mean annual fishing mortality of anchovy in the GSA 09.

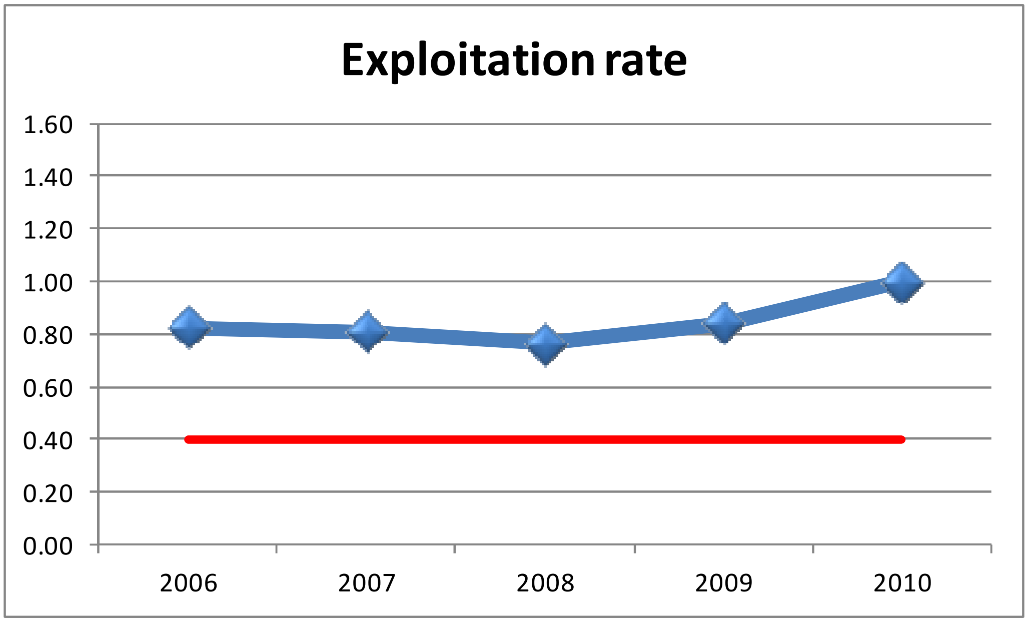


Fig. 6.16.4.1.3.3. LCA outputs: exploitation rate of anchovy in the GSA 09.

6.16.5 Short term prediction

A short term prediction of stock size and catches of various management options will be accomplished during the follow up meeting (16-20 January 2012).

6.16.6 Long term prediction

6.16.6.1 Justification

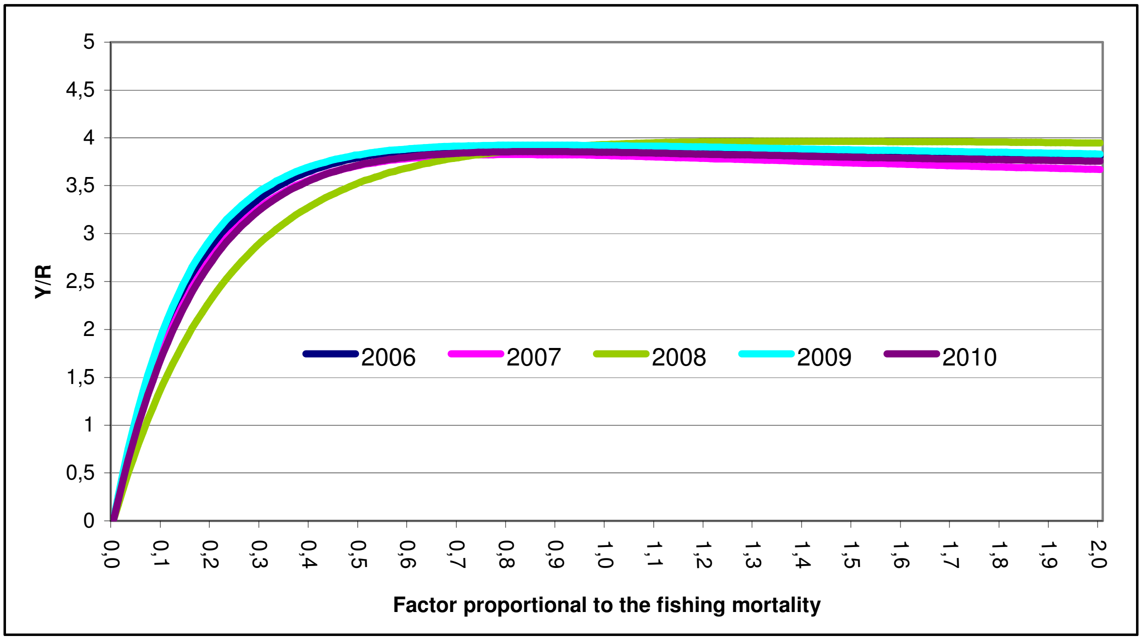
The YpR analysis as resulting from the VIT (LCA) model are demonstrated below. The results were rejected for small pelagics by the EWG.

6.16.6.2 Input parameters

Are identical with the inputs and results from the VIT assessment described above.

6.16.6.3 Results

The YpR results are shown below. These results are rejected from the EWG.



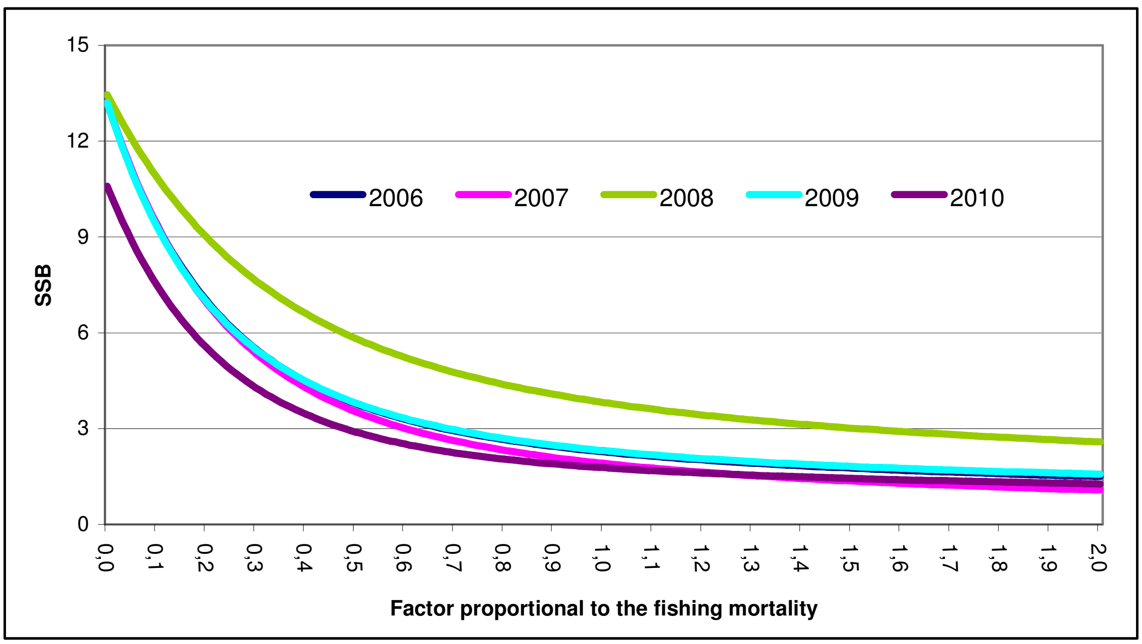


Fig. 6.16.5.3.1. Yield per recruit (above) and SSB (below) in relation to the factor proportional to the fishing mortality; 1 corresponds to the current level of F.

6.16.7 Data quality

Demographic data of the purse seine landing for 2009 and 2010 were available to EWG-11-12. Although the landing of anchovy coming from other gears (trawl and gillnet) is about 5% of the total landing, no information on the demographic composition is available for them. Data concerning fishing activity and fishing effort of the purse seine fleet for GSA 09 have been regularly submitted by the Italian Authorities.

6.16.8 Scientific advice

6.16.8.1 Short term considerations

6.16.8.1.1 State of the spawning stock size

In the absence of proposed or agreed precautionary management reference points, EWG 11-12 is unable to fully evaluate the state of biomass. The analyses carried out on the data referred to the period 2006-2010 give SSB estimations ranging from 1022 to 1461 tons for the period 2007-2010, with a peak in 2006 (2154 tons). Both landings and survey indices indicate the stock being at a low level recently (2004-2010).

6.16.8.1.2 State of recruitment

The analyses carried out on the data referred to the period 2006-2010 do not allow to obtain information on the state of recruitment.

6.16.8.1.3 State of exploitation

EWG 11-12 proposes E≤0.4 as limit management reference point consistent with high long term yields. The current exploitation rate is higher than the reference point suggested by Patterson (0.4). Applying the exploitation rate as a reference point, this stock must be considered as overexploited and F needs a consistent reduction from the current value towards the candidate reference points to achieve long term sustainability.

The results obtained from the assessments performed for the period 2006-2010, associated to the heavy reduction of the landings observed in the last twenty years suggest the adoption of plan for the recovery of this important resource as a matter of urgency. All the management options need to take into account the effect on sardine, as purse seine fleet operating in the GSA 09 contemporary exploit anchovy and sardine. This aspect should be taken into account for the management options that will be implemented in the future.

EWG notes that mere effort management of fisheries targeting stocks of small pelagics implies a high risk due to their schooling behavior and the multi-species character of their fisheries (changing target species as available and appropriate).EWG 11-12 rather recommends the consideration of landing restrictions as a more effective management tool for small pelagics. EWG 11-12 recommends a multi-annual management plan being implemented taking into account mixed-fisheries effects, in particular the technical relation with sardine fisheries.

6.17 Stock assessment of hake in GSA 11

6.17.1 Stock identification and biological features

6.17.1.1 Stock Identification

This stock is assumed to be confined within the GSA 11 boundaries, where it is distributed between 30 and 650 m of depth, with a peak in abundance (due to high number of recruits) over the continental shelf-break (between 150 and 250 m depth). The stock is mainly exploited by the local fishing fleet, although seasonally and occasionally some other Italian fleet use to fish in some areas of the GSA 11. Spawning is taking place almost all year round, with a peak during winter –spring.

Juveniles showed a patchy distribution with some main density hot spots (nurseries) showing a high spatio-temporal persistence (Murenu *et al*., 2007) in western areas.

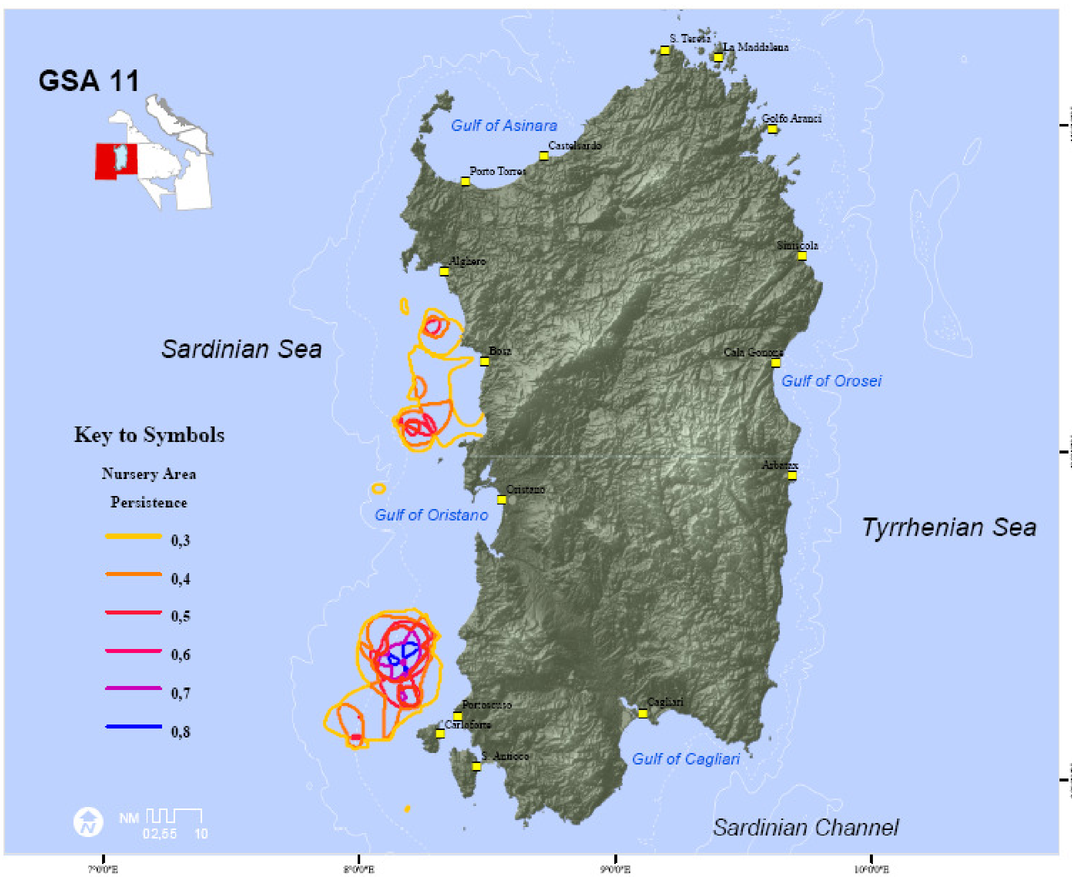


Fig. 6.17.1.1.1 Temporal persistence of hake nurseries calculated from data survey time-series density maps (1994-2006) of juveniles.

6.17.1.2 Growth

Analysis of LFDA of hake in GSA 11 showed a slow growth pattern both in male and female (SAMED, 2002). A slower growth pattern for the GSA 11 hake population comes also from otolith readings. New Von Bertalanffy Growth Function parameters have been calculated and used in this assessment. This is in line with recent evidences that suggest a fast growing pattern hypothesis for hake either in the Western Mediterranean (Garcia-Rodriguez and Esteban, 2002; Jadaud *et al*., 2006; Piñeiro *et al*., 2007) or in the Bay of Biscay (De Pontual *et al*., 2003).

6.17.1.3 Maturity

Due to the low catchability of large hake in trawl, the catch rate of mature specimens during the MEDITS trawl survey is usually very low, influencing the identification of gonad development and growth rate for large individuals. Female length at first maturity is estimated at around 36 cm. Although spawning around Sardinian coasts (GSA 11) occurs nearly all over the year (January to September), a maturity peak is usually observed in winter and spring (February-May).

6.17.2 Fisheries

6.17.2.1 General description of fisheries

Hake is one of the most important commercial species in the Sardinian seas. In this area, the biology and population dynamics have been studied intensively in the past fifteen years. Although hake is not a target of a specific fishery, such as for example red shrimp, it is the third species in terms of biomass landed in GSA 11 (Murenu M., pers. com.). In the GSA 11 hake is caught exclusively by a mixed bottom trawl fishery at depth between 50 and 600 m. No gillnet or longline fleets target this species. Although different nets are used in shallow, mid and deep water (“terra” mainly targeting *Mullus* spp., “mezzo fondo” targeting fish and “fondale” net targeting deep shrimp) the main trawl used is an “Italian trawl net” type with a low vertical opening (max up to 1.5 m). The dimensions of the trawl change in relation to the trawlers engine power. Important by catch species are horned octopus, squids, poor cod, shortnose greeneye, greater forkbeard and pink shrimp.

Detailed maps of the fishing-grounds are reported in Murenu *et al*. (2006). Most of the effort is concentrated within a relative short distance around the major fishing ports (Cagliari, Alghero, Porto Torres, La Caletta, Sant’antioco, Oristano, Alghero). Moreover, some large trawlers move seasonally in different fishing grounds far from the usual ports.

From 1994 to 2004, the trawl fleet showed remarkable changes in GSA 11. Those mostly consisted of a general increase in the number of vessels and by the replacement of the old, low tonnage wooden boats by larger steel boats. For the entire GSA an increase of 85% for boats >70 tons class occurred. A decrease of 20% for the smaller boats (<30 GRT) was also observed.

6.17.2.2 Management regulations applicable in 2010 and 2011

As in other areas of the Mediterranean, the management of this stock is based on the control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures), and minimum landing sizes (EC 1967/06). Two small closed areas were also established along the mainland (west and east coast respectively) although these are defined to mainly protect Norway lobster. Since 1991, a fishing closure for 45 trawling days has been enforced (month and year are reported on the following figure) almost every year.

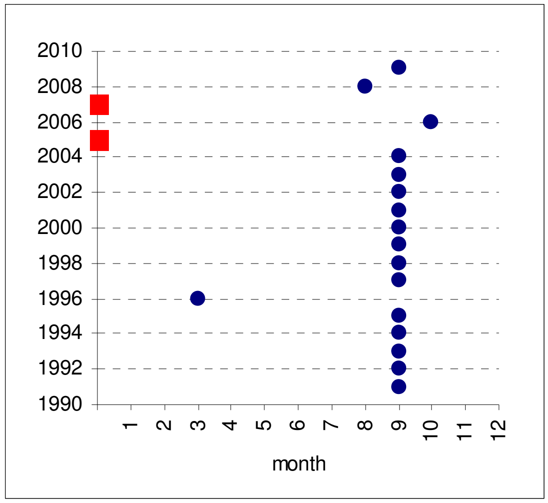


Fig. 6.17.2.2.1 Month and year of the fishing closure. Red points show the years when no closing measure was adopted.

Towed gears are not allowed within the three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

6.17.2.3 Catches

6.17.2.3.1 Landings

Landings available for GSA 11 by major fishing gears are listed in Tab. 6.17.2.3.1.1. Landings decreased from 866 t (2005) to 268 t in 2009 (Fig. 6.17.2.3.1.1). In 2010 the OTB landing are still low (268 t) while the increase in GTR landings (57,7 t) come across a minor increase of total values. Landings of hake are mostly taken by the demersal trawl fisheries (OTB) that in average account for about the 88,8% of the total.

Tab. 6.17.2.3.1.1 Landings (t) by year and major gear types, 2005-2010 as reported through DCF in 2010.

GEAR	2005	2006	2007	2008	2009	2010
GTR	101	206		28,6		57,7
LLS					7,02	
OTB	765	594	442	279	261	267
total landings (all gears)	866	800	442	307	268	324

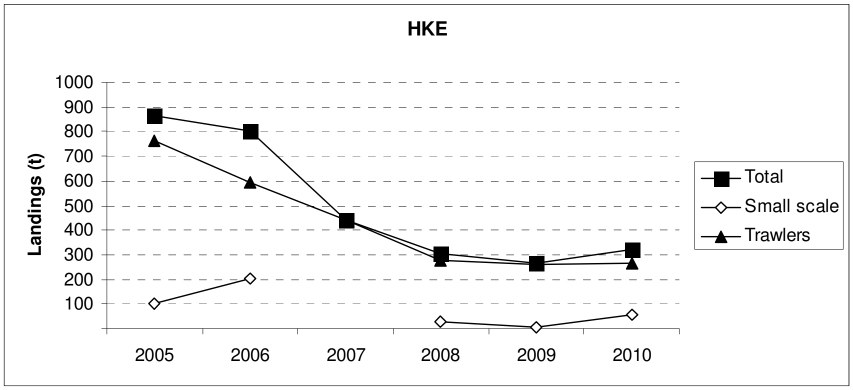


Fig. 6.17.2.3.1.1 Landings (t) by year and major gear types, 2005-2010 as reported through DCF.

6.17.2.3.2 Discards

Discards reported to STECF EGW-11-12 were null for 2007 and 2008 as shown in Tab. 6.17.2.3.2.1. The discard decrease observed in the last two years reflect the drop observed in the same period for total landings.

Tab. 6.17.2.3.2.1 Discards (t) by year, 2005-2010, as reported through DCF in 2010.

	2005	2006	2007	2008	2009	2010
total discards	387	234			169	125

Looking to the length of the discard data the information seems to be not realiable. Discards data were neither continuous by gear nor by year. Moreover the discard from GTR belongs only to large size specimens, that usually are not discarded by commercial fleets as shown by trawlers' discards data (Fig. 6.17.2.3.1.2).

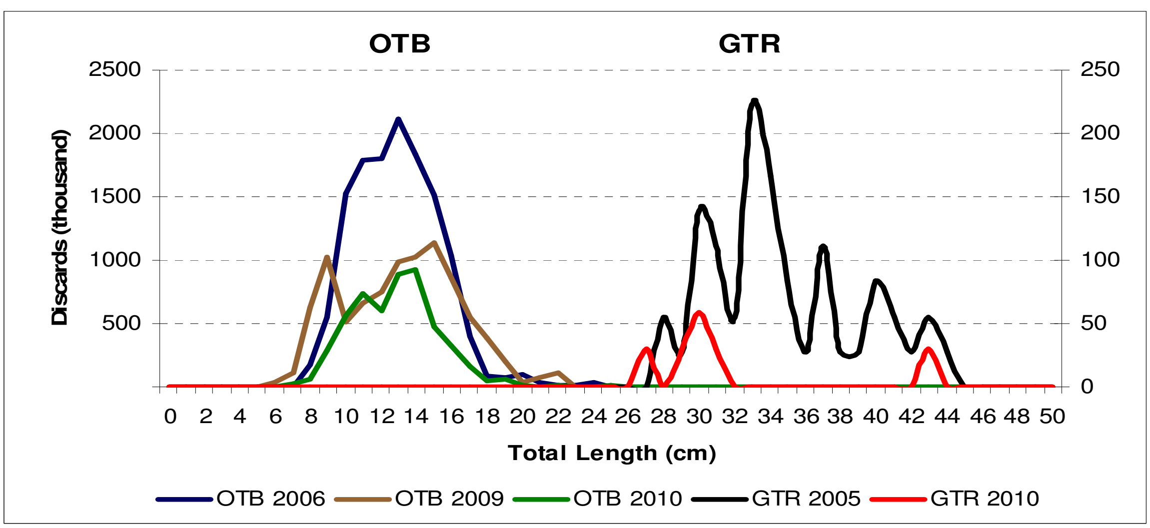


Fig. 6.17.2.3.1.1 Discards (t) by length, year and major gear types, 2005-2010 as reported through DCF.

6.17.2.4 Fishing effort

The reported fishing effort values through the DCF data call was changed and updated for 2010.

Using data available to EGW-11-12, the trends in fishing effort by year and major gear type is listed in Tab. 6.17.2.4.1 and shown in Fig. 6.17.2.4.1 in terms of kW*days. The trend analysis show a major drop of total fishing effort in 2008, when both the trawlers and the small scale fishery effort decrease (of 25 and 31 % respectively). In the last three years the effort was almost stable.

Tab. 6.17.2.4.1 Trend in fishing effort (kW*days) for Italy in GSA 11 for the major gear types in 2004-2010.

GEAR	2004	2005	2006	2007	2008	2009	2010
FPO	42030	77070	960931	1497019	921315	1039432	999287
FYK				1140			
GNS	1157504	1065868	204874	777750	453491	979982	558828
GTR	6584427	7186648	7227466	4932023	3719222	4103101	4333105
LHP							
LLD	118760	280487	468325	1311593	927405	514982	647982
LLS	1048740	941723	1329827	1135473	649943	672281	530352
LTL			6689	1744	589	566	
none	18500	786	65516	143525	62994	44038	9193
OTB	7706431	7324728	5752588	5865498	4430174	4375729	4041363
PS	27293						
total	16703685	16877310	16016216	15665765	11165133	11730111	11120110

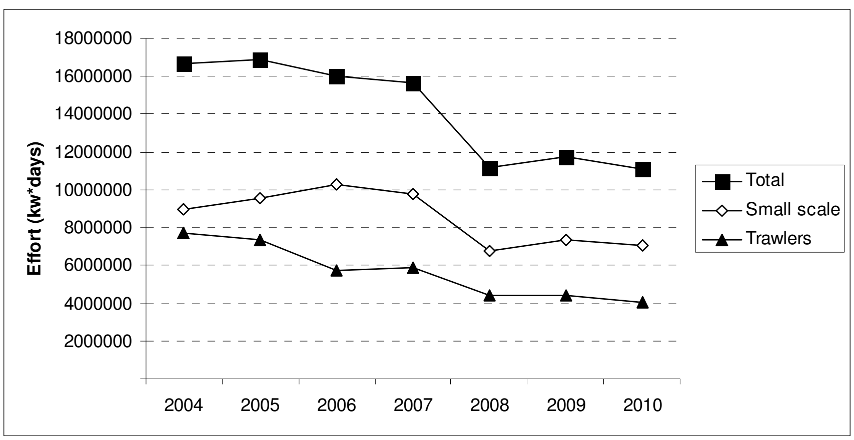


Fig. 6.17.2.4.1 Trend in fishing effort (kW*days) for the Italian fleet in GSA 11 for the major gear types in 2004-2010.

Tab. 6.17.2.4.2 Trend in fishing effort (kW*days) for Italy in GSA 11 for the major gear types in 2004-2010, as reported through the DCF in 2010.

Gear	Fishery	Vessel_Len	2004	2005	2006	2007	2008	2009	2010
-1	-1	VL1218				18134			
-1	CEP	VL0006				20678	2463		
-1	CEP	VL0612	18500	786	19378	60931	14048	4275	1804
-1	CEP	VL1218			40059	43782	21715	910	
-1	FINF	VL0612			924		24768	38853	7389
-1	FINF	VL1218			5155				
FPO	DEMSP	VL0006				76963	18326	24782	37759
FPO	DEMSP	VL0612	42030	23148	814006	1277817	846628	850868	811483
FPO	DEMSP	VL1218		53922	146925	142239	56361	163782	150045
FYK	DEMSP	VL0006				708	0	0	0
FYK	DEMSP	VL0612				432			
GNS	DEMSP	VL0006			2849	73406	21877	33984	38299
GNS	DEMSP	VL0612	1015513	694933	139688	627676	335747	687764	456896
GNS	DEMSP	VL1218	141991	370935	62337	76668	95867	258234	62966
GNS	SLPF	VL0612							667
GTR	DEMSP	VL0006			177826	113777	82800	75882	75278
GTR	DEMSP	VL0612	5143105	5481274	5787359	3778447	2795301	3228203	3353364
GTR	DEMSP	VL1218	1441322	1705374	1262281	1039799	841121	799016	904463
LLD	LPF	VL0612			114173		6485	6164	16142
LLD	LPF	VL1218	118760	280487	222267	1297228	920920	508818	631840
LLD	LPF	VL2440			131885	14365			
LLS	DEMF	VL0006			11843	17523	2947	3231	0
LLS	DEMF	VL0612	797809	691302	929070	769772	416016	449869	409875
LLS	DEMF	VL1218	250931	250421	297651	324578	230980	219181	120477
LLS	DEMF	VL1824			9933				
LLS	DEMF	VL2440			81330	23600			
LTL	LPF	VL0612			6689	1744	589	566	
OTB	DEMSP	VL0612				1063		152685	193464
OTB	DEMSP	VL1218	1243040	1270821	1475054	134032	1347750	1305105	1176411
OTB	DEMSP	VL1824	55011				829163	700410	571926
OTB	DEMSP	VL2440				19496	259152	218124	138829
OTB	DWSP	VL1218							3769
OTB	DWSP	VL1824							2323
OTB	DWSP	VL2440					139531	199345	270999
OTB	MDDWSP	VL1218				1281844	86074		51154
OTB	MDDWSP	VL1824	2606247	2955031	1870402	1986365	387260	559080	619426
OTB	MDDWSP	VL2440	3802133	3098876	2407132	2442698	1381244	1240980	1013062
PS	SPF	VL1218	27293						
			16703685	16877310	16016216	15665765	11165133	11730111	11120110

6.17.3 Scientific surveys

6.17.3.1 MEDITS

6.17.3.1.1 Methods

Since 1994 the MEDITS trawl surveys have been yearly carried out between May and July (except in 2007).

According to the MEDITS protocol (Relini, 2000; Bertand *et al.*, 2002) a stratified random sampling design with allocation of hauls proportional to depth strata extension (depth strata: 10–50 m, 51–100 m, 101–200 m, 201–500 m, 501–800 m) was adopted. A specific gear (GOC 73, with a 20 mm stretched mesh size in the cod-end) was always used following the instruction stated and reported in Dremière and Fiorentini (1996).

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 11 the following number of hauls was reported per depth stratum (s. Tab. 6.17.3.1.1.1).

Tab. 6.17.3.1.1.1. Number of hauls per year and depth stratum in GSA 11, 1994-2010.

RATUM	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
A11_010-050	16	18	21	21	21	20	19	17	20	18	17	17	19	19	17	18	19
A11_050-100	25	21	22	22	20	22	22	24	19	19	18	21	18	20	19	20	19
A11_100-200	20	23	30	31	31	30	29	30	24	24	24	24	24	24	22	24	24
A11_200-500	33	29	29	26	25	27	24	25	20	24	21	20	20	20	21	19	20
A11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	17	16	16	17
al	117	107	123	125	122	123	121	122	99	99	95	96	97	100	95	97	99

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma\,(Yi*Ai) / A$
$V(Yst) = \Sigma\,(Ai^2 * si^2 / ni) / A^2$
Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = $Yst \pm t$(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.17.3.1.2 Geographical distribution patterns

The spatial distribution of European hake has been described by modelling the spatial correlation structure of the abundance indices using geostatistical techniques (i.e. kriging). In different studies either total abundance index or abundances of recruits and adults were analysed (Murenu *et al*., 2007).

On average, considering the analyzed yearly distributions (1994-2005), the recruits were considered individuals smaller than 12.3 cm (±1.41). These individual are belonging to the age 0 group. Persistence of the nursery areas along the years was studied by applying indicator kriging technique (Journel 1983, Goovaerts, 1997) to abundance estimations of recruits (Murenu *et al*., 2008). Main results and maps are reported in the “nursery section” of SGMED 09-02 report.

6.17.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the hake in GSA 11 was derived from the international survey MEDITS. Figure 6.17.3.1.3.1 displays the estimated trend in hake abundance and biomass in GSA 11.

The estimated abundance and biomass indices since 1999 show high variation without any trend.

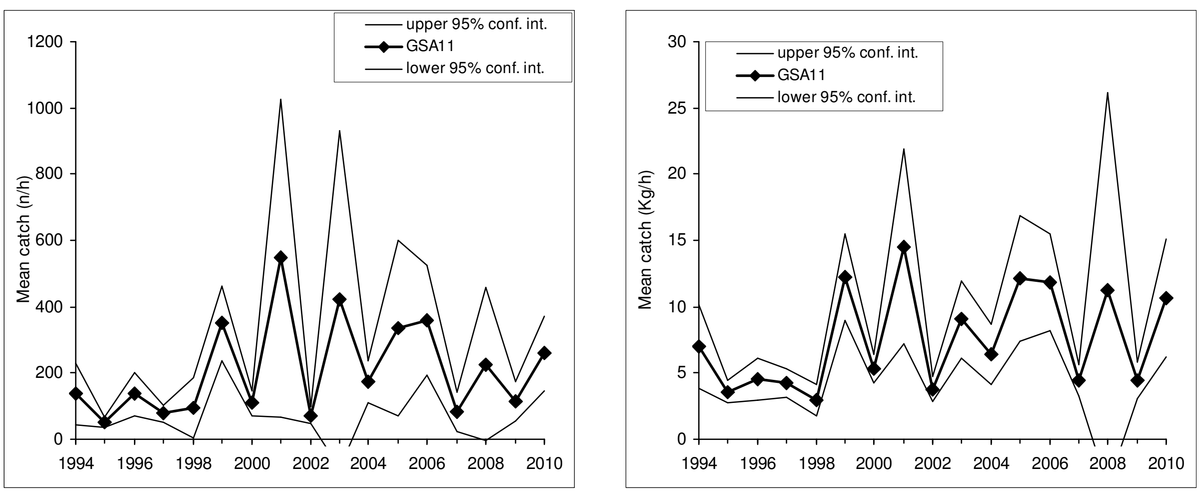


Fig. 6.17.3.1.3.1 Abundance and biomass indices of hake in GSA 11.

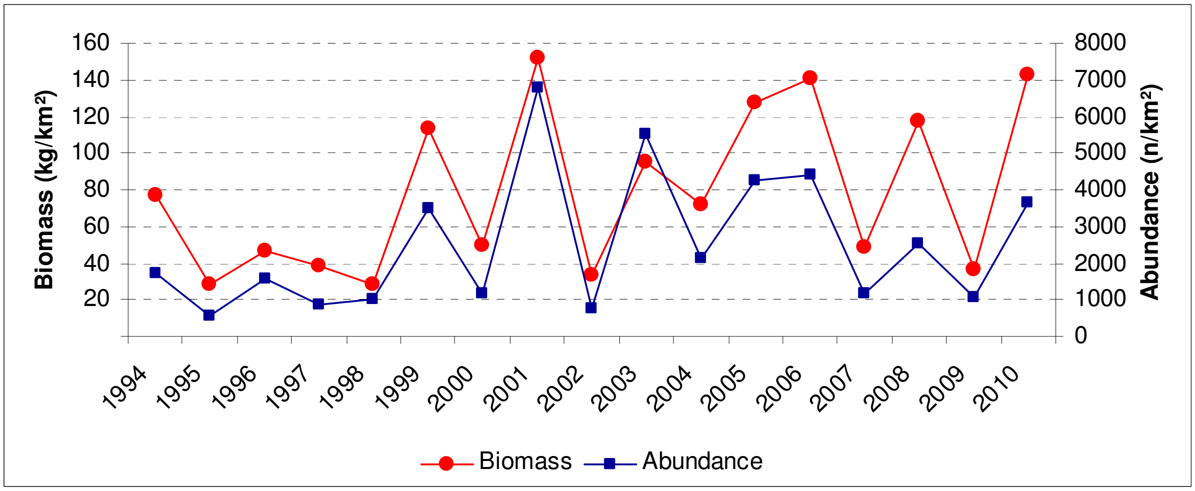


Fig. 6.17.3.1.3.2 Abundance and biomass indices of hake in GSA 11.

6.17.3.1.4 Trends in abundance by length or age

The following Fig. 6.17.3.1.4.1 and 2 display the stratified abundance indices of GSA 11 in 1994-2001 and 2002-2010 respectively.

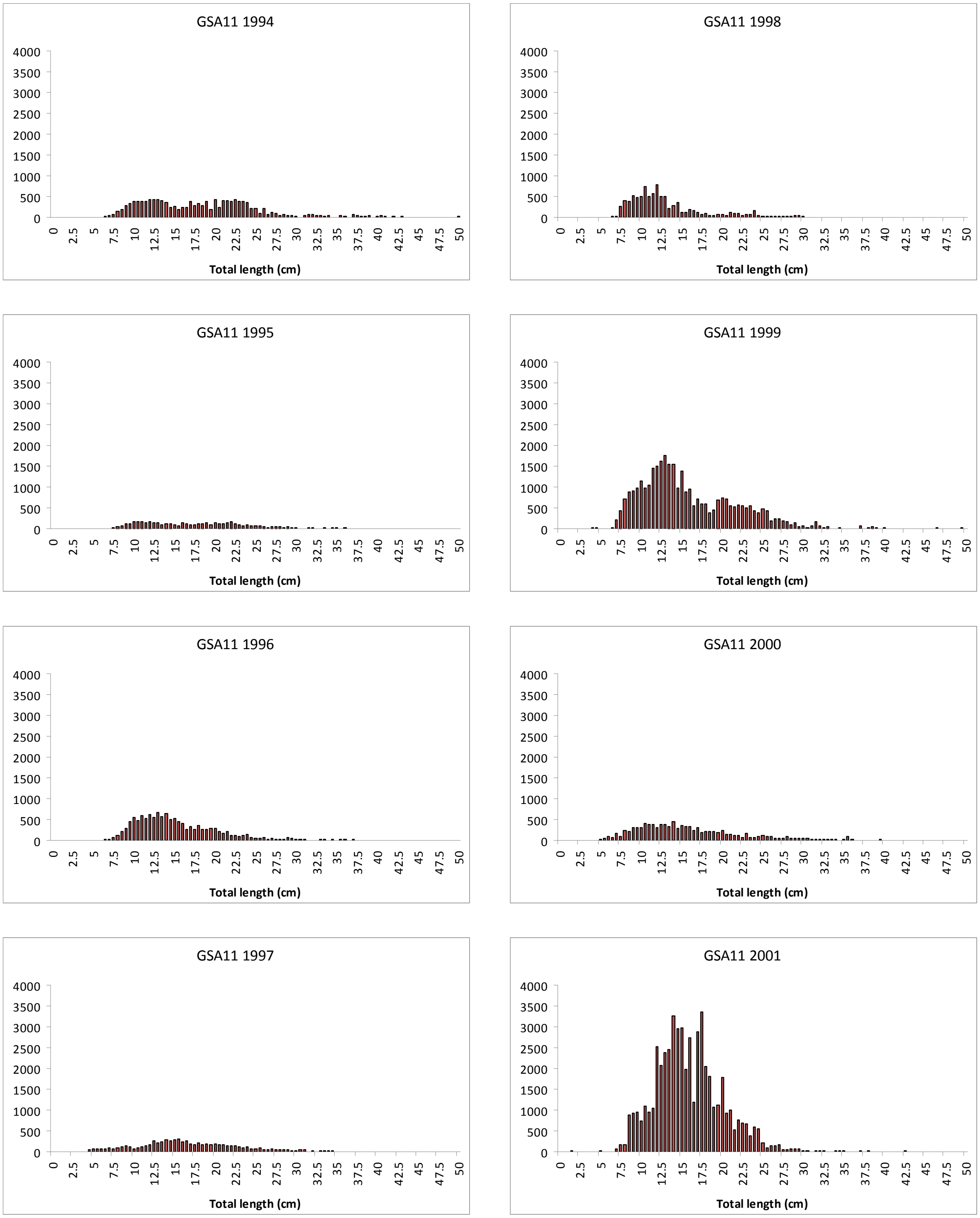
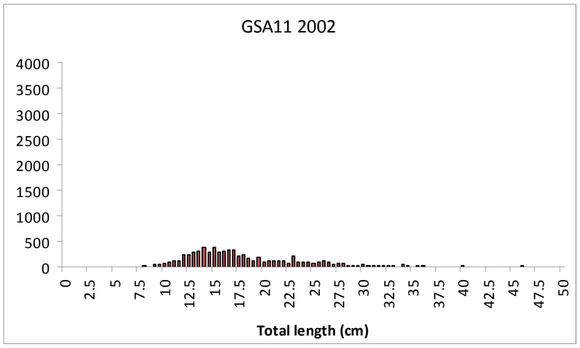
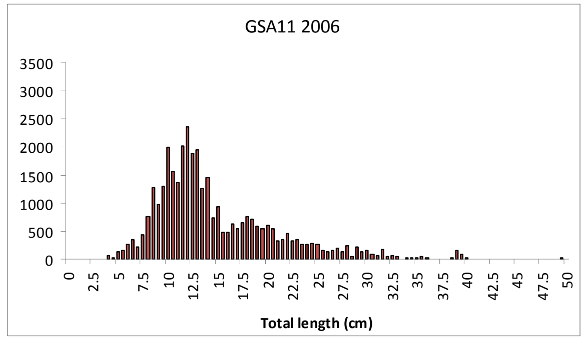
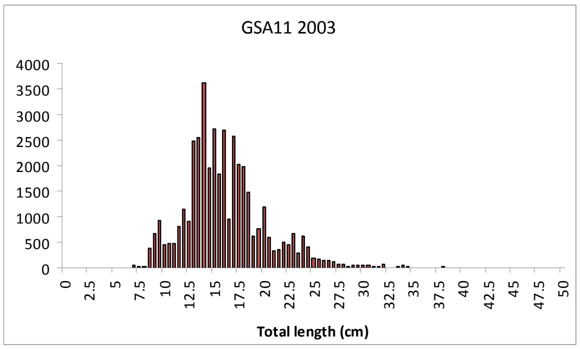


Fig. 6.17.3.1.4.1 Stratified abundance indices by size, 1994-2001.


GSA11 2002
4000
3500
3000
2500
2000
1500
1000
500
0
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50
Total length (cm)


GSA11 2006
3500
3000
2500
2000
1500
1000
500
0
0
2.5
5
7.5
10
12.5
15
17.5
20
22.5
25
27.5
30
32.5
35
37.5
40
42.5
45
47.5
50
Total length (cm)


GSA11 2003
4000
3500
3000
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0
0
2.5
5
7.5
10
12.5
15
17.5
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37.5
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42.5
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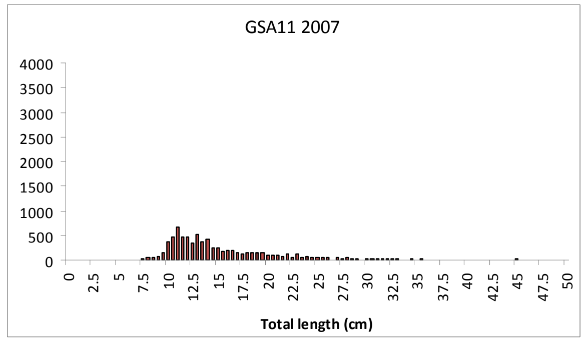
47.5
50
Total length (cm)


GSA11 2007
4000
3500
3000
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2000
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1000
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0
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2.5
5
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17.5
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37.5
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42.5
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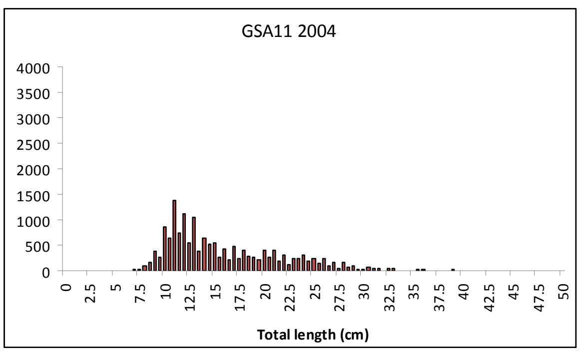
47.5
50
Total length (cm)


GSA11 2004
4000
3500
3000
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2000
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1000
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2.5
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7.5
10
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37.5
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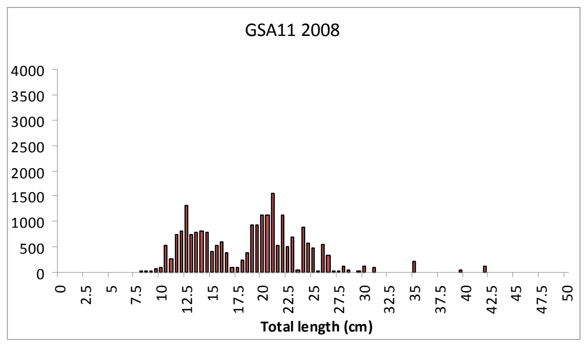
42.5
45
47.5
50
Total length (cm)


GSA11 2008
4000
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17.5
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37.5
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42.5
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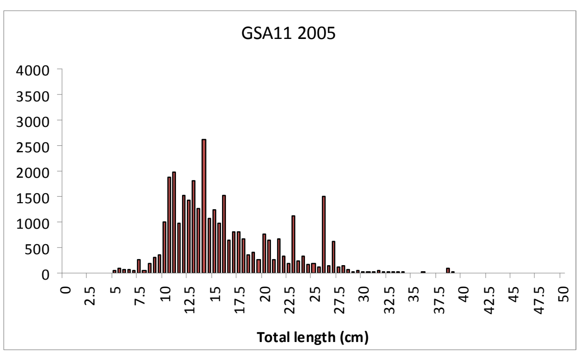
47.5
50
Total length (cm)


GSA11 2005
4000
3500
3000
2500
2000
1500
1000
500
0
0
2.5
5
7.5
10
12.5
15
17.5
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32.5
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37.5
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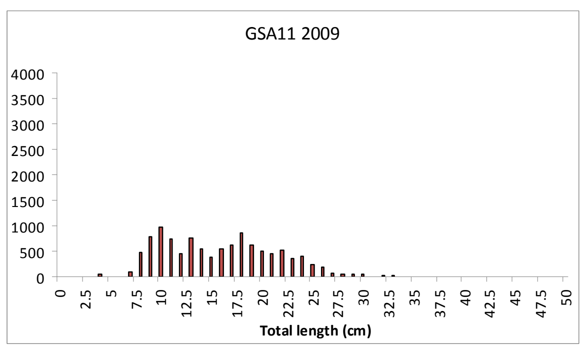
42.5
45
47.5
50
Total length (cm)


GSA11 2009
4000
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3000
2500
2000
1500
1000
500
0
0
2.5
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7.5
10
12.5
15
17.5
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22.5
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27.5
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37.5
40
42.5
45
47.5
50
Total length (cm)

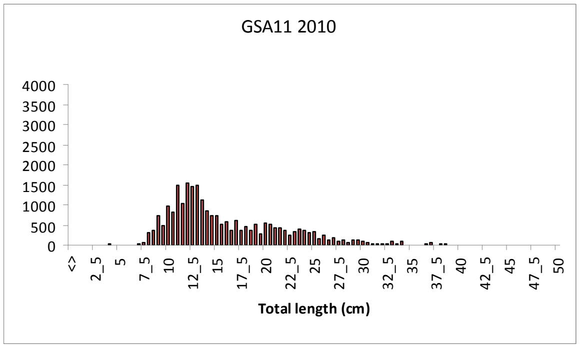


Fig. 6.17.3.1.4.2 Stratified abundance indices by size, 2002-2010.

6.17.3.1.5 Trends in growth

No analyses were conducted.

6.17.3.1.6 Trends in maturity

No analyses were conducted.

6.17.4 Assessment of historic stock parameters

6.17.4.1 Method 1: SURBA

6.17.4.1.1 Justification

The MEDITS survey provided the longer standardized time-series data on abundance and population structure of *M. merluccius* in the GSA11 which allows utilizing the SURBA software for the assessment. The SURBA assessment tool reconstructs the evolution of F from length frequency distribution (LFD).

The SURBA was applied to the MEDITS survey estimates.

6.17.4.1.2 Input parameters

Data from trawl surveys (time series of MEDITS from 1994 to 2010) and effort and landings data from DCR have been used for the analysis. The SURBA software package (Needle, 2003) use trawl surveys data available from MEDITS to reconstruct trend in population structure and fishing mortality of hake in GSA 11.

The LFDs were converted in numbers at age using both LFDA and an "age slicing" subroutine as implemented in the R program introduced by the working group.

Tab. 6.17.4.1.2.1 Input data used in the SURBA model.

	Survey index data (CPUE) splitted by LFDA						**Survey index data (CPUE) splitted by r routine**					
	Age						Age					
Year	0	1	2	3	4	5+	0	1	2	3	4	5+
1994	8934	3886	261	31	0	0	12933	168	12	0,069	0,003	0,003
1995	3427	1250	40	2	2	1	4699	22	1	0,552	0,053	0,003
1996	10993	1349	46	23	2	2	12294	84	27	1,167	0,014	0,007
1997	5625	1513	19	5	2	0	7157	6	1	0,117	0,003	0,002
1998	8351	916	24	49	0	1	9203	58	80	0,191	0,144	0,021
1999	27281	6079	142	7	1	0	33404	75	3	0,148	0,005	0,002
2000	8415	1732	66	10	1	0	10176	45	4	0,131	0,003	0,003
2001	47999	5196	71	10	0	1	53157	89	5	0,161	0,014	0,003
2002	5251	1712	80	9	4	0	6949	100	8	0,399	0,005	0,003
2003	36947	4317	36	2	1	0	41247	55	1	0,100	0,002	0,001
2004	13485	3131	64	8	0	0	16642	43	3	0,034	0,003	0,003
2005	26736	6062	90	5	0	0	32862	30	2	0,011	0,001	0,001
2006	30324	4354	259	107	6	0	34604	257	111	3,833	0,063	0,011
2007	6789	1039	91	14	1	1	7907	27	2	0,169	0,013	0,004
2008	15961	5949	160	13	0	0	21980	100	4	0,035	0,002	0,001
2009	8886	2106	23	10	0	0	11002	10	4	0,044	0,004	0,004
2010	20045	4401	74	2	0	1	24444	50	1	0,039	0,034	0,006

Age	0	1	2	3	4	5+
Proportion mature	0	0,1	0,9	1,0	1,0	1,0
Mean weights	0,01	0,01	0,07	0,20	0,39	0,63

The VBGF parameters used to split the LFD has not been changed from those used in the previous SGMED and match to a fast growth set as L_{∞}=100,7 cm, K=0.248, t_0= -0.01.

According to the Prodbiom approach developed by Caddy and Abella (1999), a vectorial natural mortality at age was estimated (Tab. 6.17.4.1.2.2). Guess-estimates of catchability by age are also given in Tab. 6.17.4.1.2.2.

Tab. 6.17.4.1.2.2 Input parameters used in the SURBA analysis (sex combined) in GSA11.

Growth parameters		
Linf	100.7	cm total length
K	0.248	
t_0	-0.01	
Natural mortality		
M vector		Age_1=1.11,Age_2=0.51,Age_3=0.40,Age4=0.35,Age_5=0.33
Length at maturity		
L50	36	cm total length (sex combined)
Catchability (q)		q_0=0.8,q_{1-3}=1.0,q_4=0.75,q_5=0.6

6.17.4.1.3 Results 1 (LFDA slicing)

The fitted year effect show high fluctuations in the whole time series. Moreover an increasing trend could be observed since 2005 (5.9.4.1.3.1). The age effect show a trend decreasing patter with high values for stock mortality at age 1 and 2. The Fitted cohort effects are slight increasing from 1998.

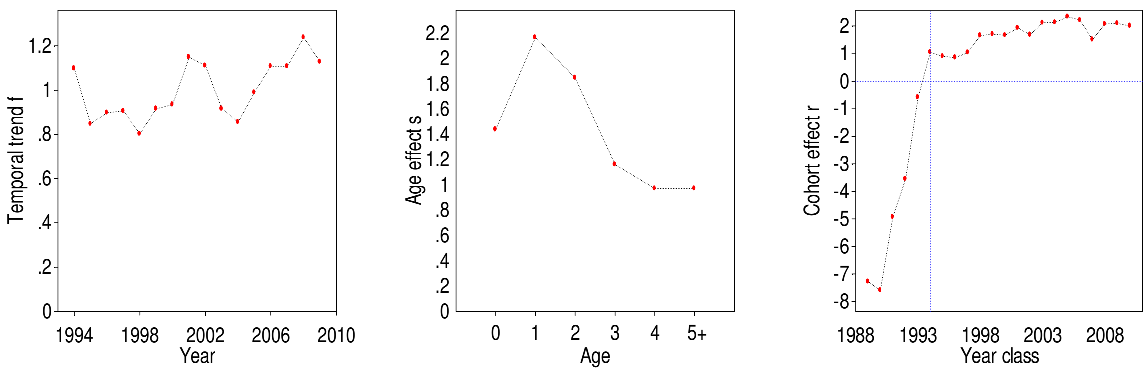


Fig. 6.17.4.1.3.1 MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

As shown in Fig. 6.17.4.1.3.2 relative indices of spawning stock biomass (SSB) showed a peak in 1994, 2000 and 2006, with a clear drop in the last years. Relative indices estimated by SURBA indicated very high fluctuations of recruitment in the period 1994-2010, with large recruitment observed in 2001, 2003 and 2005.

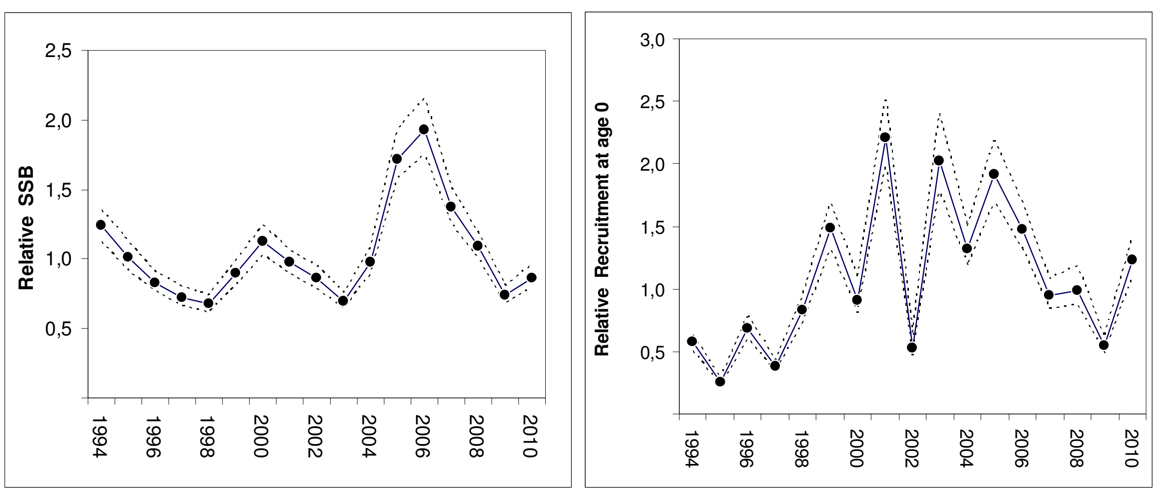


Fig. 6.17.4.1.3.2. Relative SSB, relative recruitment index at age 0 and estimated trend in F_{1-3} of *M. merluccius* in the GSA11. Dotted lines are 2.5% and 97.5% confidence intervals.

Average fishing mortality (F_{1-3}) estimated from trawl survey data (MEDITS) range between 1.4 and 2.5 with a mean value of 1.7 (Fig. 6.17.4.1.3.3). These SURBA results also show that the mean F for ages 1-3 was high and stable until 2009 then, in 2010, increasing up to the maximum value.

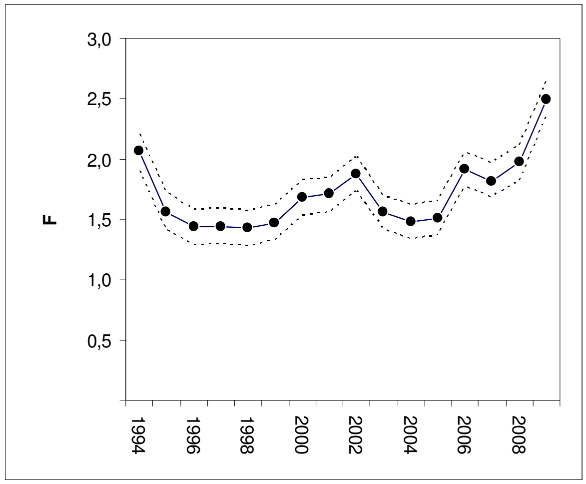
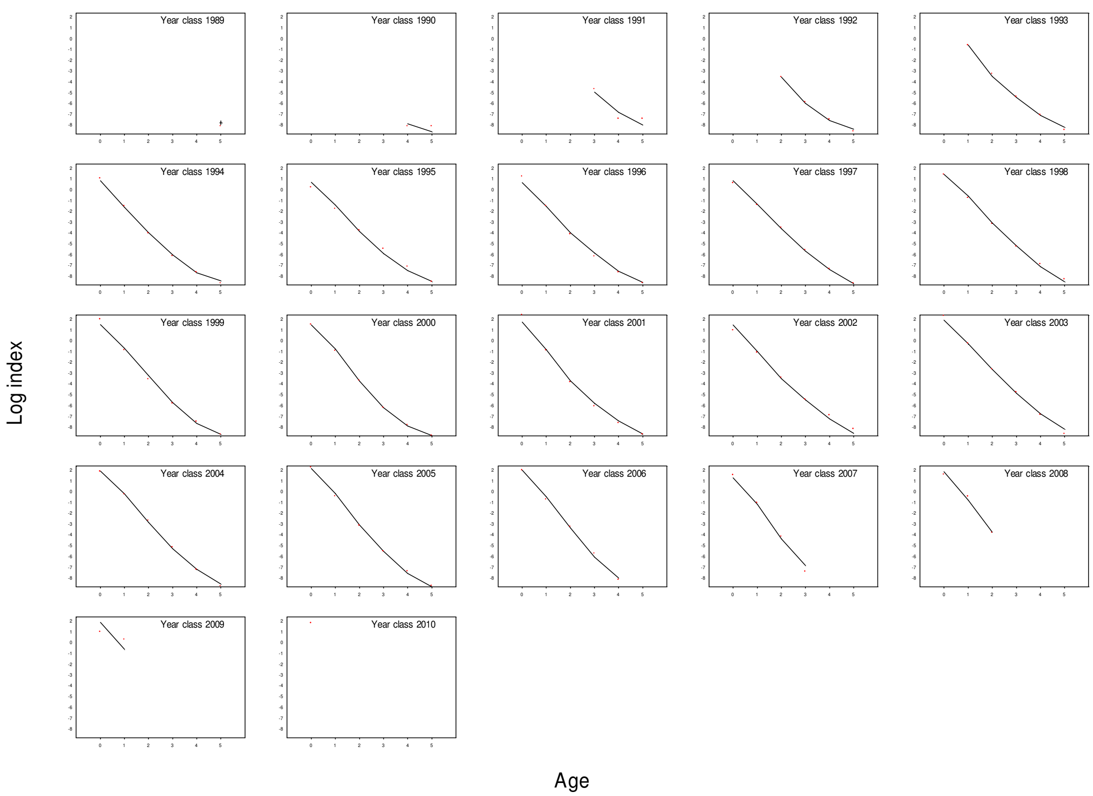


Fig. 6.17.4.1.3.3. Estimated trend in F_{1-3} of *M. merluccius* in the GSA11. Dotted lines are 2.5% and 97.5% confidence intervals.

Model diagnostics

The SURBA model for *M. merluccius* fits well on survey data and do not highlight trends in the residuals as showed by comparison between observed and fitted abundance indices per year, comparative scatterplot at age, catch curves and residual of the log index abundance (Fig. 6.17.4.1.3.4).



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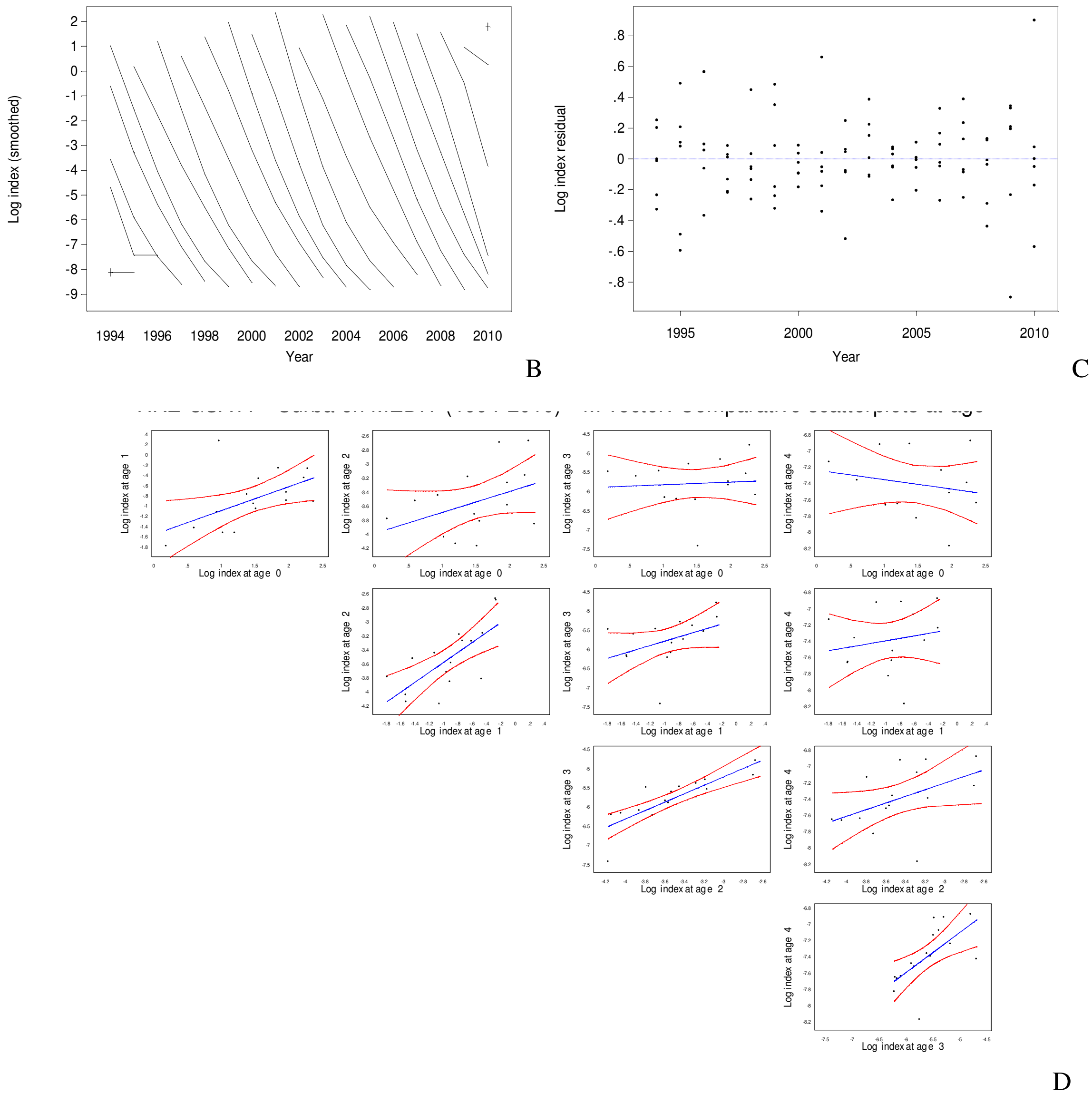


Fig. 6.17.4.1.3.4 Model diagnostic for SURBA model in the GSA 11 (MEDITS survey). A) Comparison between observed (points) and fitted (lines) survey abundance indices, for each year; B) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life; C) Log index residuals over time and D) Comparative scatterplots at age.

6.17.4.1.4 Results 2 (r slicing)

The fitted year effect show high fluctuations in the whole time series. Moreover an increasing trend could be observed since 2005 (Fig. 6.17.4.1.3.1) as shown in the previous analysis (fig. 6.17.4.1.3.1). The age effect shows a decreasing trend patter with high values for stock mortality for all the first ages (0-2). The fitted cohort effects are higher than in the other model.

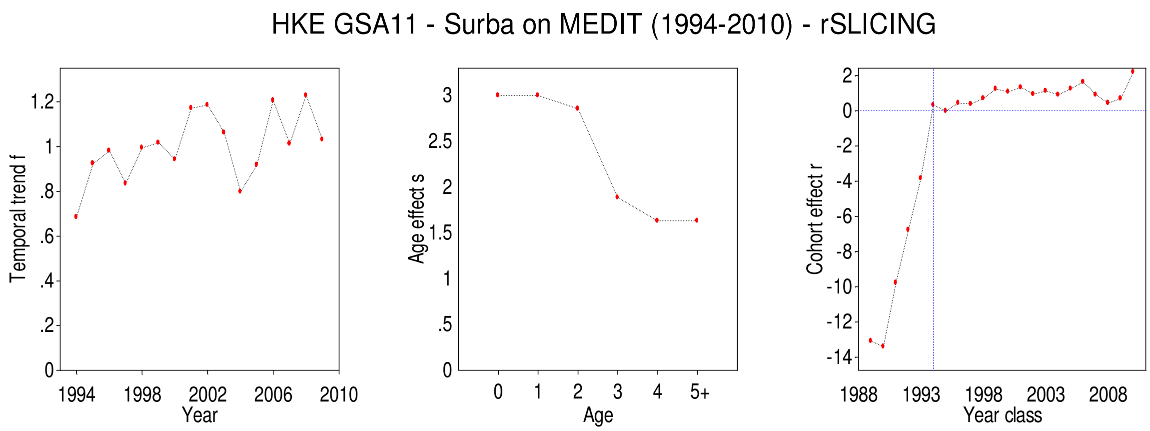


Fig. 5.9.4.1.3.1 MEDITS survey. Fitted year, age and cohort effects estimated by SURBA.

As shown in Fig. 6.17.4.1.3.2 the relative indices of spawning stock biomass (SSB) showed a similar pattern and the same peak in 1994, 2000 and 2006, with a clear drop in the last years. The same pattern is also showeed for the relative indices estimated by SURBA which also here indicated very high fluctuations of recruitment in the period 1994-2010, with large recruitment observed in the last years.

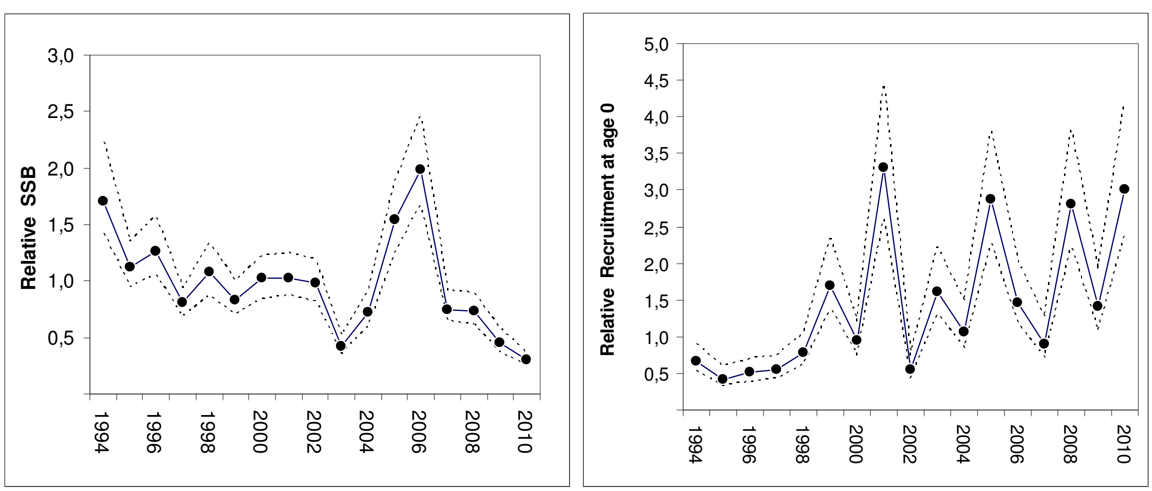


Fig. 6.17.4.1.3.2. Relative SSB, relative recruitment index at age 0 and estimated trend in $F_{1\text{-}3}$ of *M. merluccius* in the GSA11. Dotted lines are 2.5% and 97.5% confidence intervals.

Average fishing mortality ($F_{1\text{-}3}$) estimated from trawl survey data (MEDITS) range between 1.5 and 3.13 with a mean value of 2.52 (Fig. 6.17.4.1.3.3). These SURBA results also show a different patter from the previous model particularly in the last 10 years.

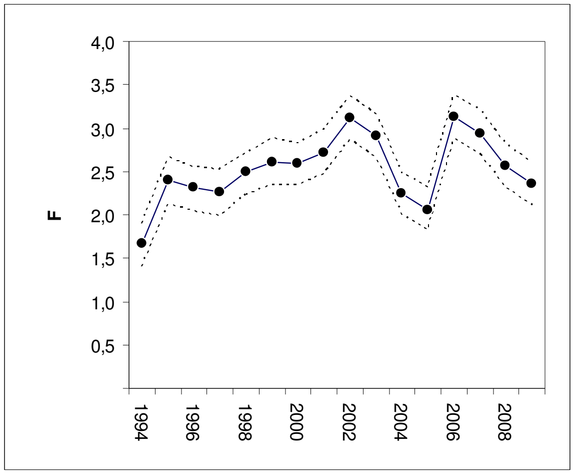
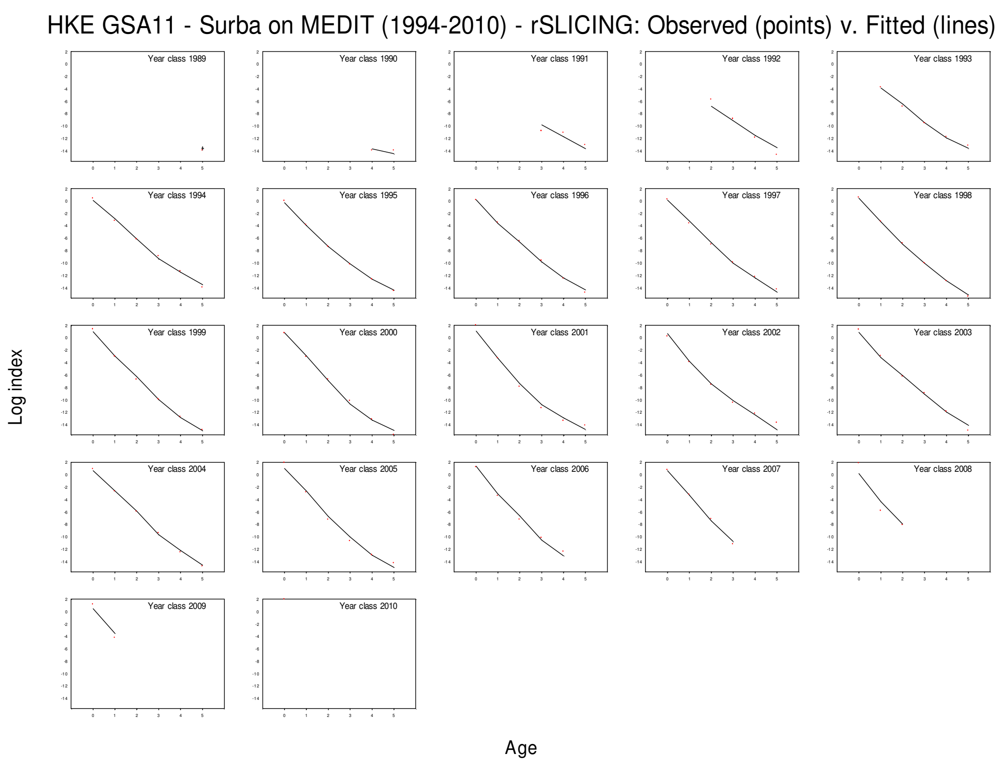


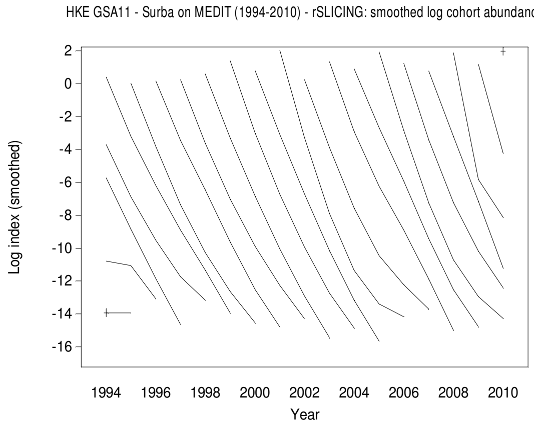
Fig. 6.17.4.1.3.3. Estimated trend in $F_{1\text{-}3}$ of *M. merluccius* in the GSA 11. Dotted lines are 2.5% and 97.5% confidence intervals.

Model diagnostics

The SURBA model for European hake show a worse fitting of the previous model used with the LFDA sliced data, particularly on comparative scatterplot at age, catch curves and residual of the log index abundance. However the fitting showed in all the figures reported below can be considered aceptable to sustain the analysis (Fig. 6.17.4.1.3.4).



A



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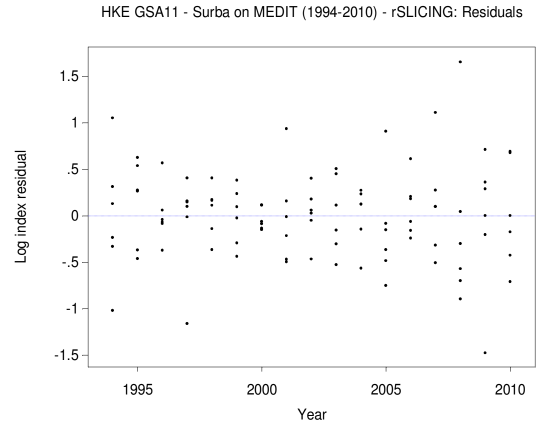

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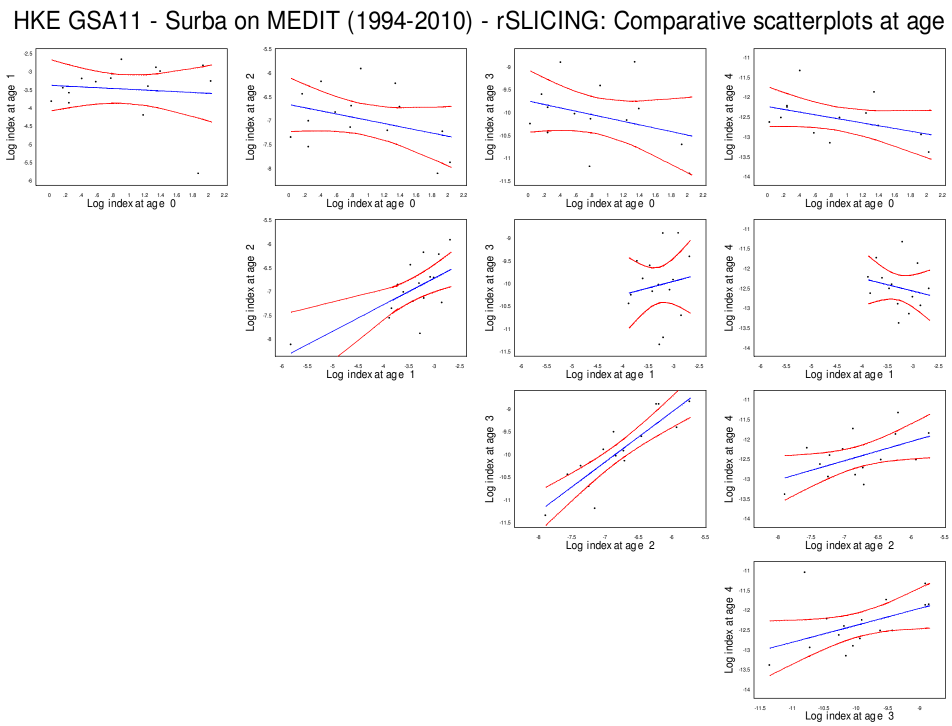


D

Fig. 6.17.4.1.3.4 Model diagnostic for SURBA model in the GSA 11 (MEDITS survey, r slicing). A) Comparison between observed (points) and fitted (lines) survey abundance indices, for each year; B) Log survey abundance indices by cohort. Each line represents the log index abundance of a particular cohort throughout its life; C) Log index residuals over time and D) Comparative scatterplots at age.

Because of the fitting dicussed above here, STECF EGW 11-12 conclude that the analysis on data coming out from LFDA slicing procedure seems to be more consistent and then to be preferred for the assessment.

6.17.4.2 Method 2: LCA

6.17.4.2.1 Justification

This LCA assessment of hake in the GSA 11 was performed aimed at the estimation of a vector of F at size, using data on total annual catches by size. Considering some data quality constrains it was chosen to postpone a formal VPA to the next EGW. Here a pseudo-cohort analysis is carried out appling a VIT to the last 3 years landing data (2008-2010).

6.17.4.2.2 Input parameters

Data coming from DCR provided at SGMED-EGW 11-12 contained information on hake landings and the respective size structure for 2005-10 (Fig. 6.17.4.2.2.1).

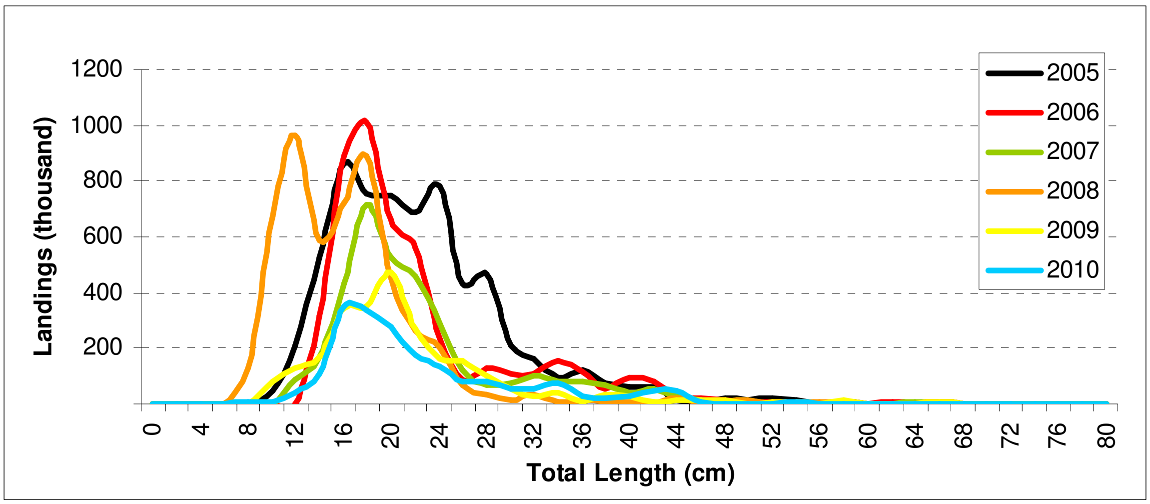
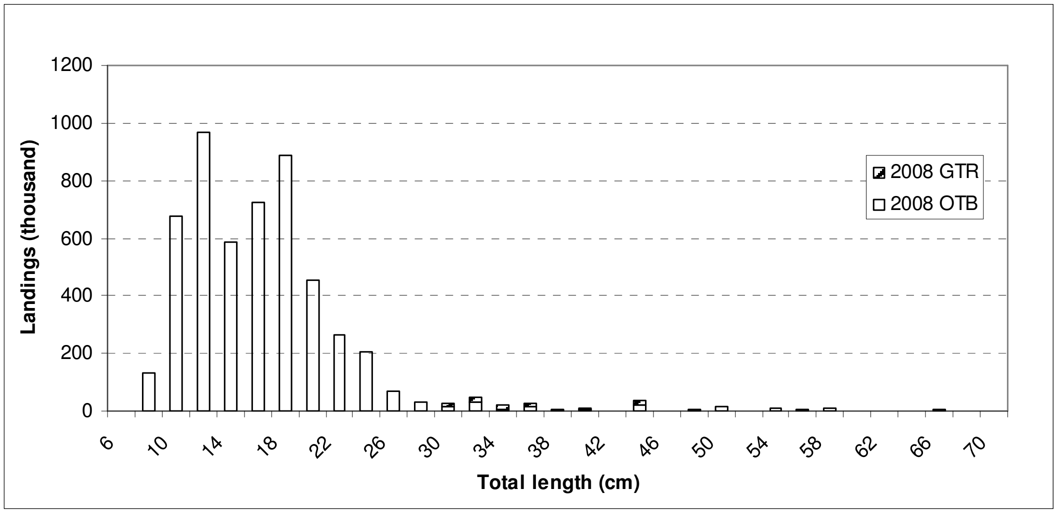


Fig. 6.17.4.2.2.1Length frequency distributions of the landings by year available to EGW 11-12.

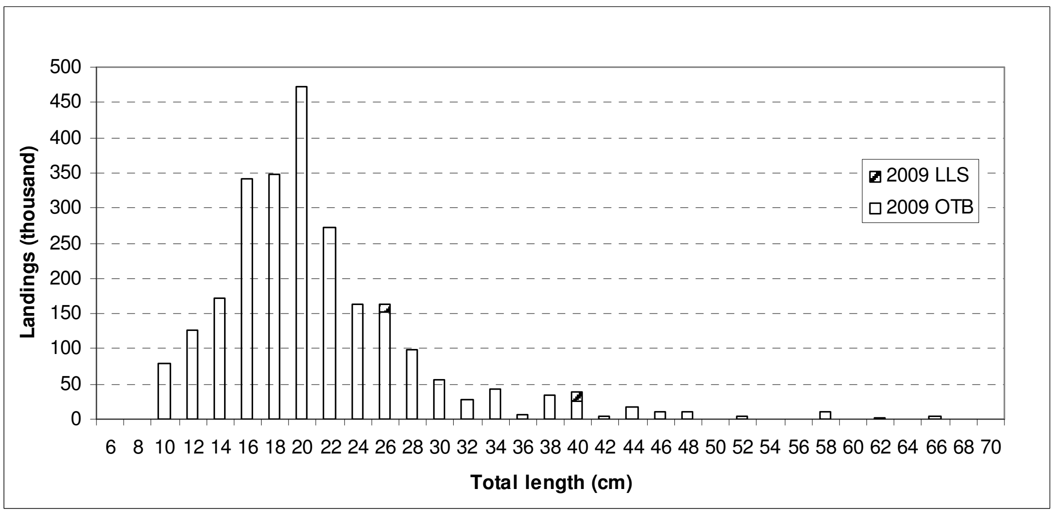
From this data set the last 3 years were used to run an LCA analysis using the VIT software (Tab 6.17.4.2.2.1, Fig. 6.17.4.2.2.2). An M vector, the same used for SURBA, was utilized. No discard data were used because of their poor quality and reliability (see comment on data quality section).

Tab. 6.17.4.2.2.1 Input data for LCA of hake in GSA11 (sex combined, 2008-10).

GEAR TL(cm)	OTB 2008	OTB 2009	OTB 2010	GTR 2008	LLS 2009	GTR 2010
6	0	0	2	0	0	0
8	130	0	5	0	0	0
10	675	79	5	0	0	0
12	965	127	37	0	0	0
14	588	171	105	0	0	0
16	723	341	353	0	0	0
18	889	348	339	0	0	0
20	454	473	278	0	0	0
22	262	272	178	0	0	7
24	204	163	133	0	0	0
26	67	152	82	0	12	0
28	31	100	78	0	0	0
30	14	55	54	12	0	21
32	33	28	54	12	0	35
34	4	44	73	17	0	56
36	14	6	29	12	0	0
38	4	34	19	0	0	42
40	4	27	25	5	12	7
42	0	4	48	0	0	14
44	20	16	45	15	0	0
46	0	11	4	0	0	0
48	4	11	2	0	0	0
50	13	0	2	0	0	0
52	0	4	0	0	0	0
54	9	0	5	0	0	0
56	4	0	0	0	0	0
58	9	11	3	0	0	0
60	0	0	2	0	0	0
62	0	3	2	0	0	0
64	0	0	0	0	0	0
66	4	4	2	0	0	0
68	0	0	0	0	0	0
70	0	0	0	0	0	0



A



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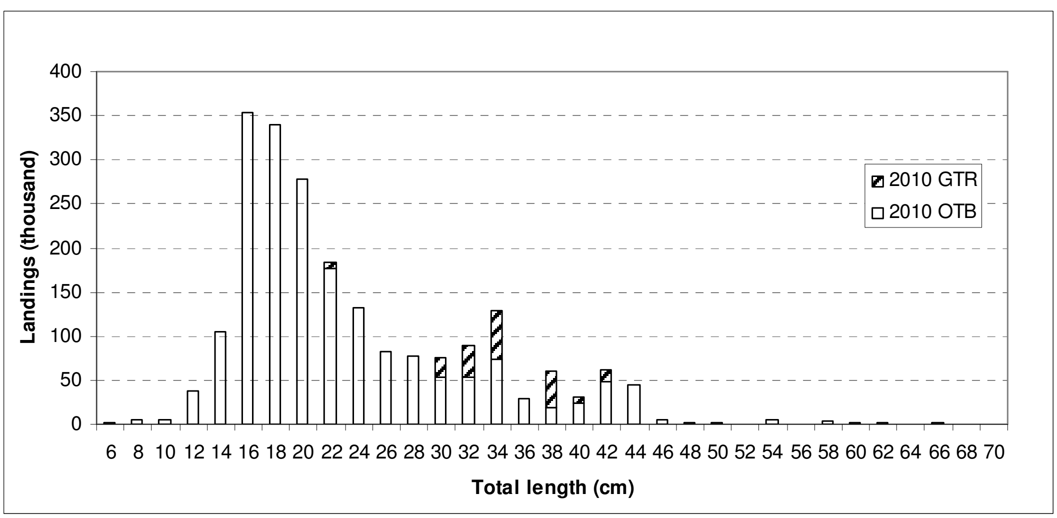


C

Fig. 6.17.4.2.2.2 Length frequency distributions of the landings of *M. merluccius* by gear in GSA11 (2008-10).

6.17.4.2.3 Results

Hake landings in the time series considered were concentrated on age classes 0-2 and the estimated fishing mortality peaked for specimens of age class 1 (Fig. 6.17.4.2.3.1). $F_{0.1}$ was 0.25. F_{0-2} was 0.6 while F_{1-2} was 0.63.

Tab. 6.17.4.2.3.1. Fbar by years for *M. merluccius* in the GSA11.

year	2008	2009	2010	mean 08-10
$F_{(0-2)}$	**0,61**	**0,49**	**0,69**	**0,60**
$F_{(1-2)}$	**0,47**	**0,56**	**0,86**	**0,63**
$F_{(0-3)}$	**0,49**	**0,39**	**0,54**	**0,48**

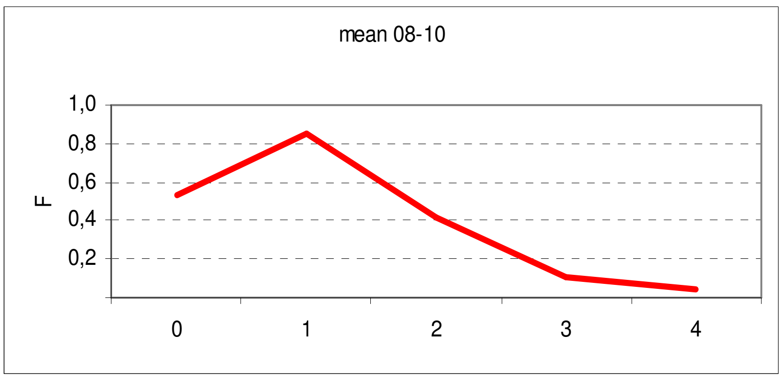


Fig. 6.17.4.2.3.1. LCA output: fishing mortality by ages of *M. merluccius* in the GSA11.

Assuming no variation in the exploitation pattern, the main results of the Y/R analysis are reported in Tab. 6.17.4.2.3.2.

Table 6.17.4.2.3.2 The main results of the VIT analysis.

Year	Yield (t)	Recruitment (ml)	F	Z
2008-10	278662	9	0.39	0,93

6.17.5 Long term prediction

For the long term predictions both VIT and YIELD software were used.

6.17.5.1 Method 1: VIT

6.17.5.1.1 Justification

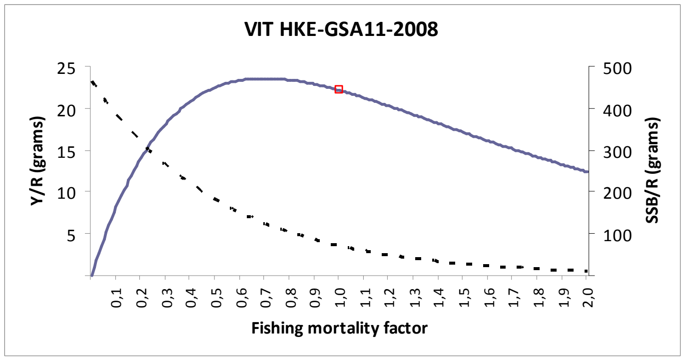
Y/R analyses as implemented in the package VIT4win (Lleonart and Salat 2000) were used to studying the stock production with increasing exploitation under equilibrium conditions.

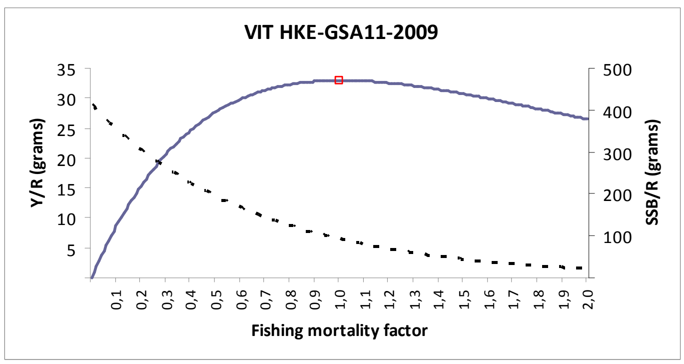
6.17.5.1.2 *Input parameters*

Input parameters are given in section XX on the VIT assessment above. Landing data come from DCF call for GSA 11.

6.17.5.1.3 *Results*

The VIT results regarding the long term prediction are presented below (Fig. 6.17.5.1.3.1).





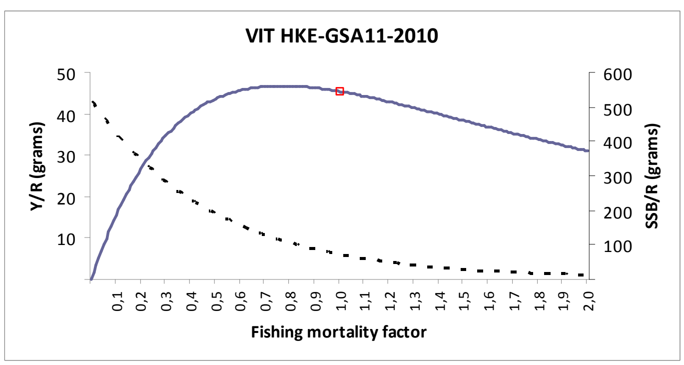


Fig. Fig. 6.17.5.1.3.1 Spawning Stock Biomass (SSB) and Yield (Y) per recruit by different level of F factor (year 2008-2010).

6.17.5.2 Method 2: YIELD

6.17.5.2.1 Justification

One of the greatest sources of uncertainty in fisheries management is the very high year to year variability in recruitment. Including such stock recruitment relationship (SRR) in an analytical YPR model changes its predictions considerably.

The Yield software (Hoggarth *et al*., 2006), that allows for uncertainty in parameter inputs, was used to estimate $F_{0.1}$ as target equilibrium YPR reference point for the stock assuming some uncertainty in parameters estimations.

6.17.5.2.2 Input parameters

The following parameters used to estimate $F_{0.1}$ through Yield software were reported below (Tab 6.17.5.2.2.1).

Moreover a guess estimate of uncertainty in terms of coefficient of variation was added to each parameter.

Recruitment was derived from the mean of the estimated age 0 classes computation by VIT in 2008,2 009 and 2010.

An estimation of F was obtained from Z – M by the Beverton and Holt Z estimator.

Tab. 6.17.5.2.2.1. Input to long term forecast.

$L\infty$ = 100.7 cm total length
K = 0.248
t_0 = -0.01
a = 0.004
b = 3.156
M = 0.6 CV=0.005
L_{50} = 36 cm, normally distributed CV=0.05
Lc100 = 10 cm, normally distributed CV=0.05
Spawning season: January-December
Fishing season: January-December
Stock-recruit relationship (SRR) constant recruitment 9 million CV=0.2; uncertainty in R0=0.1

6.17.5.2.3 Results

The probability distribution of $F_{0.1}$ (1000 simulations) was shown below (Fig. 6.17.5.2.3.1). Uncertainty in model parameters produced considerable variations in $F_{0.1}$ which ranged between 0.2 and 0.3 (F0.1mean = 0.24).

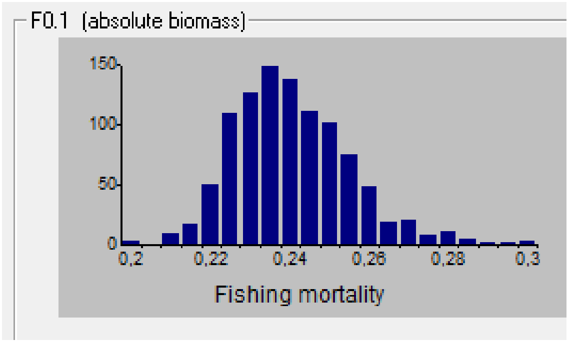


Fig. 6.17.5.2.3.1 Probability distribution of $F_{0.1}$ obtained using the Yield software.

According to these calculations, F_{curr} (0.39 from VIT) was above the average (0.24) and the maximum (0.30) estimated $F_{0.1}$ values.

$F_{0.1}$ was assumed as target reference point. F_{ref} were considered as limit reference points. F_{ref} is the F where the ratio SSB/initial SSB is equal to 0.30. The following mean values were obtained: $F_{0.1}$= 0.24 and F_{ref} = 0.39.

6.17.6 Data quality

MEDITS survey data were available from 1994 to 2010 with unreported of TC table for some yers (1994-1998). Effort data shows several changes from those reported in the previous SGMED.

Also landings data (see B Fisheries landings at length data MED 2002-2010 20110920.accdb datatable) are different from those reported in the previous STECF SGMED meeting (see B Fisheries landings at length data MED and BS 2002-2009 20110420.accdb data table). Particularly landings at length, which now include all years from 2005, shows changes both in data and gears for the last database. Discards data are lacking in some years. Moreover their length distribution seems to be not realiable for the GTR fleet segment because they belong to specimens greater than 28 cm in total length, that usually are not discarded as shown by trawlers' discards data.

All these limit the LCA analysis and highligth the need of a cross check process in order to full validation the data submitted. Due to this data inconsistency STECF EGW 11-12 decide to not accept the VIT assessment.

6.17.7 Scientific advice

6.17.7.1 Short term considerations

6.17.7.1.1 State of the spawning stock size

No biomass reference points have been proposed for this stock. As a result, EWG 11-12 is unable to fully evaluate the status of the stock with respect to biomass.

6.17.7.1.2 State of recruitment

No reference points have been proposed.

Relative indices estimated by SURBA indicated very high fluctuations of recruitment in the period 1994-2010, with a clear decreasing trend in the last five years.

6.17.7.1.3 State of exploitation

EWG 11-12 was not able to accept the VIT assessment due to landing data inconsistency. However, both SURBA and VIT showed an ovefishing status of hake in GSA 11. Thus, EWG 11-12 recommends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

6.18 Stock assessment of giant red shrimp in GSA 11

6.18.1 Stock identification and biological features

6.18.1.1 Stock identification

Due to a lack of information about the structure of the giant red shrimp in the western Mediterranean, this stock was assumed to be confined within the GSA 11 boundaries.

In GSA 11 *Aristaeomorpha foliacea* (Risso, 1827) represents one of the most important demersal resources for the trawling fleet. It is found below 350 m on muddy bottoms. The highest abundances are present in the Southern area while the Eastern coast shows lower values (AAVV, 2008).

The recruitment of *A. foliacea* occurs generally between 400 and 600 m (D'Onghia et al., 2007; Politou et al., 2004); in Sardinian waters, *A. foliacea* recruits (specimens with carapace length CL≤11.5 mm) were found between 500 and 550 from October to December (Mura et al., 1997).

6.18.1.2 Growth

The von Bertalanffy Growth Function parameters of *A. foliacea* by sex in Sardinian seas, available in the scientific literature, are reported in Table 6.18.1.2.1. The species show a marked difference in growth between sexes, with females reaching bigger length than males: the observed maximum length for females resulted 68 mm of CL and for males 48 mm of CL.

Tab. 6.18.1.2.1. Von Bertalanffy Growth function parameters for *Aristaeomorpha foliacea* in the GSA 11.

females			males			
L_∞	**k**	**t_0**	**L_∞**	**k**	**t_0**	**Author**
75.40	0.46	0.58	49-53	06-0.67	0.001-0.3	Cau et al., 1994
70.70	0.54	0.27				Cau et al., 2002
72.21	0.50	0.00	42.71	0.77	-0.27	AAVV (2008); Red's Project

6.18.1.3 Maturity

Spawning season occurs between end of July and September, with a peak in summer (July-August) (Mura et al., 1992; Cau et al., 1994; Mori et al., 1994; Spedicato et al., 1994; Ragonese and Bianchini, 1995). The length at 50% of maturity in Sardinian seas has been estimated in 32.6 mm CL for females (AAVV, 2008).

6.18.2 Fisheries

6.18.2.1 General description of fisheries

In GSA 11 the giant red shrimp represents one of the most important demersal resources for the trawling fleet. The species is exclusively exploited with otter bottom trawling. Most of the trawl effort in GSA 11 is concentrated around the major fishing ports (mainly Cagliari, Olbia and Porto Torres). The Sardinian big trawlers usually works from Monday to Saturday, generally coming back daily to the closest port in the early morning in order to send all the fish to the market. The midsized and small trawlers perform daily fishing trips, before the sunrise until the early morning, staying sometimes two days at sea.

Since 1994, Sardinian fleet has undergone considerable transformation as a consequence of government incentives aimed at its modernization. The main change has involved the replacement of the old, low-tonnage wooden boats with large deep-sea iron ones. As a result, there has been a move of the fishing pressure toward deep-sea resources, which, in the early nineties, were lightly exploited in the Sardinian seas.

6.18.2.2 Management regulations applicable in 2010 and 2011

As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area/season closures). EC regulation 1967/2006 does not provide for a minimum length size for this species. A fishing ban of 45 days for trawling boats from 1 September to 15 October has been established in Sardinia.

6.18.2.3 Catches

6.18.2.3.1 Landings

Giant red shrimp is caught only by trawlers. Landings in GSA 11 showed a decrease in the period 2005-2008, falling from about 170 to 67 t. A slight increase can be observed in the two last three years (2008-2010).

The age composition of the landings show a prevalence of age class 0+, 1 + and 2+ ().

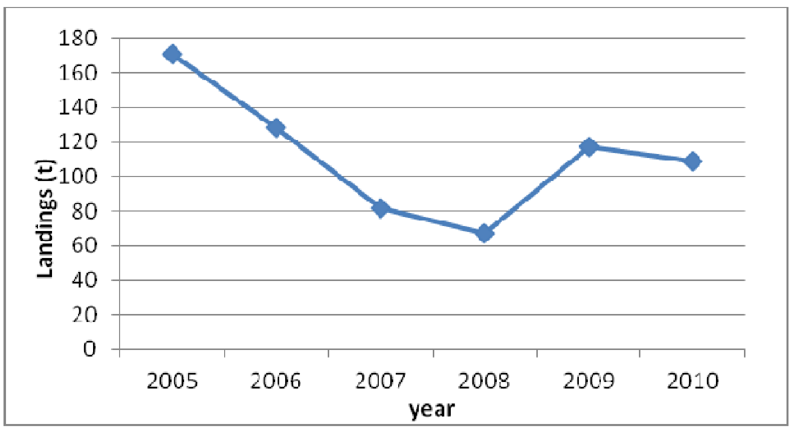


Fig. 6.182.3.1.1. Landings by trawlers of giant red shrimp in GSA 11 as reported through DCF.

Tab. 6.182.3.1.1. Annual landings (t) of *Aristaeomorpha foliacea* in GSA 11 (DCF data call 2011).

Area	Country	Gear	2005	2006	2007	2008	2009	2010
GSA 11	Italy	OTB	170.667	128.672	81.681	67.115	117.434	109.054

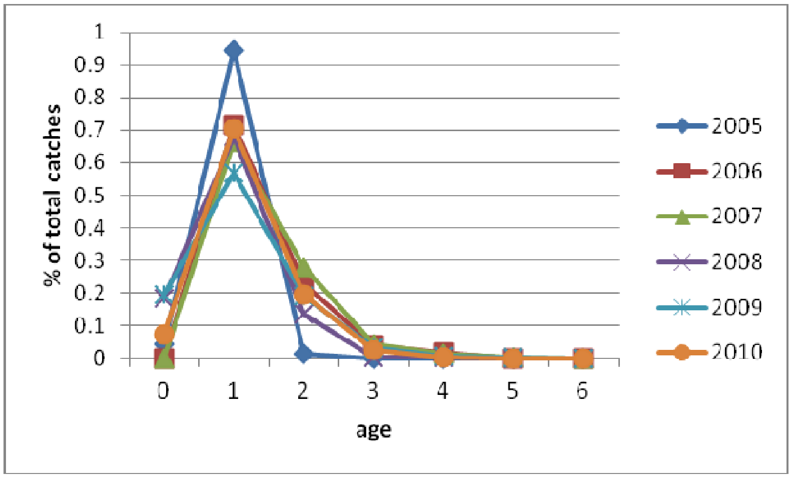


Fig. 6.182.3.1.2. Age frequency distribution of the giant red shrimp *Aristaeomorpha foliacea* in GSA 11 from 2005 to 2010 (DCF data call 2011)

6.18.2.3.2 Discards

This species is known to have no significant discards.

6.18.2.4 Fishing effort

Fishing effort in GSA 11 has gradually decreased from 2004 (7,706,431 kw*day) to 2008 (4,430,174 kw*day). Since 2008 the effort remained substantially stable.

Table 6.18.2.4.1. Annual fishing effort as nominal effort (kW*days) and GT*days at sea by gear in GSA11 from 2004 to 2010 (DCF data call 2011).

Country	Area	Year	Gear	Nominal_Effort	Gt_Days_At_Sea	No_Vessels
ITA	SA 11	2004	OTB	7,706,431	1,721,988	1,805
ITA	SA 11	2005	OTB	7,324,728	1,785,484	1,713
ITA	SA 11	2006	OTB	5,752,588	1,358,732	1,825
ITA	SA 11	2007	OTB	5,865,498	1,414,252	1,833
ITA	SA 11	2008	OTB	4,430,174	1,128,009	1,473
ITA	SA 11	2009	OTB	4,375,729	1,045,910	1,665
ITA	SA 11	2010	OTB	4,041,363	944,672	1,017

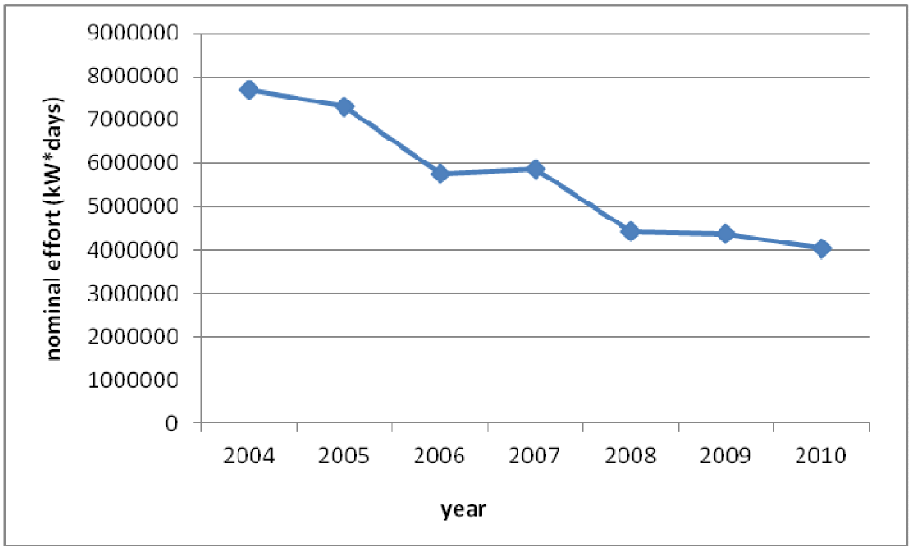


Fig. 6.18.2.4.1. Trends in annual fishing effort as nominal effort (kW*days in GSA11 (DCF 2011)

6.18.3 Scientific surveys

6.18.3.1 MEDITS

6.18.3.1.1 Methods

Since 1994 the MEDITS trawl surveys have been carried out annually between May and July (except in 2007). According to the MEDITS protocol (Bertand *et al.*, 2002) a stratified random sampling design with allocation of hauls proportional to depth strata extension (depth strata: 10–50 m, 51–100 m, 101–200 m, 201–500 m, 501–800 m) was adopted. A specific gear (GOC 73, with a 20 mm stretched mesh size in the codend) was always used.

In GSA 11 the following number of hauls was reported per depth stratum (Table 6.18.3.1.1.1).

Table 6.18.3.1.1.1. Number of hauls per year and depth stratum in GSA11, 1994-2010.

Stratum	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
GSA11_010-050	16	18	21	21	21	20	19	17	20	18	17	17	19	20	17	18	19
GSA11_050-100	25	21	22	22	20	22	22	24	19	19	18	21	18	19	19	20	19
GSA11_100-200	20	23	30	31	31	30	29	30	24	24	24	24	24	24	22	24	24
GSA11_200-500	33	29	29	26	25	27	24	25	20	24	21	20	20	21	21	19	20
GSA11_500-800	23	16	21	25	25	24	27	26	16	14	15	14	16	16	16	16	18

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Catches by haul were standardized to 60 minutes hauling duration. The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

- A=total survey area
- Ai=area of the i-th stratum
- si=standard deviation of the i-th stratum
- ni=number of valid hauls of the i-th stratum
- n=number of hauls in the GSA
- Yi=mean of the i-th stratum
- Yst=stratified mean abundance
- V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA.

6.18.3.1.2 Geographical distribution patterns

The stock is more abundant in the Southern part of GSA 11 as showed in Fig. 6.18.3.1.2.1 (from Ardizzone *et al*., Eds. CD-ROM Version). It is scarce in the North and Eastern coasts.

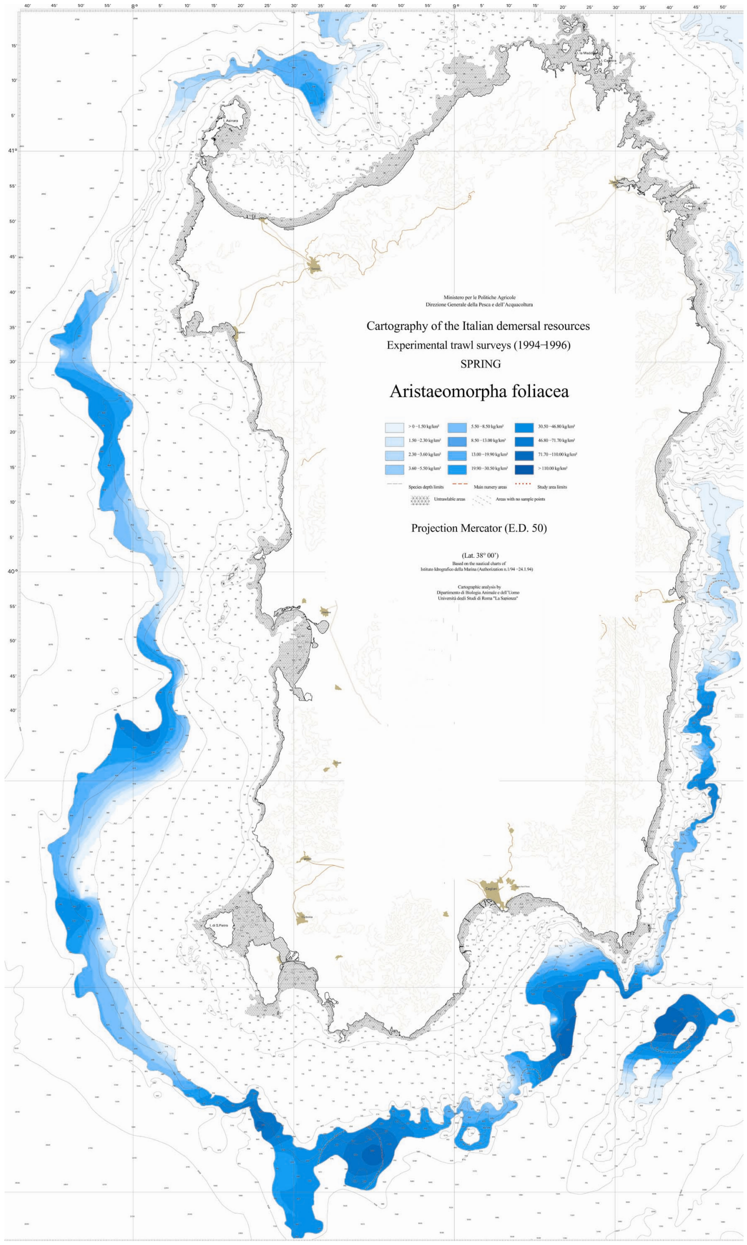


Fig. 6.18.3.1.2.1 *Aristaeomorpha foliacea*: adult specimen biomass 1994-1996, GSA 11 (Sardinian Sea).

6.18.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp in GSA 11 derive from the MEDITS international survey. MEDITS biomass (kg/h) and abundance (n/h) indices for *A. foliacea* do not show any clear trend. However, a gradual increase in abundances in the last three years, after a drop in 2007, can be noted (Fig. 6.18.3.1.3.1-2).

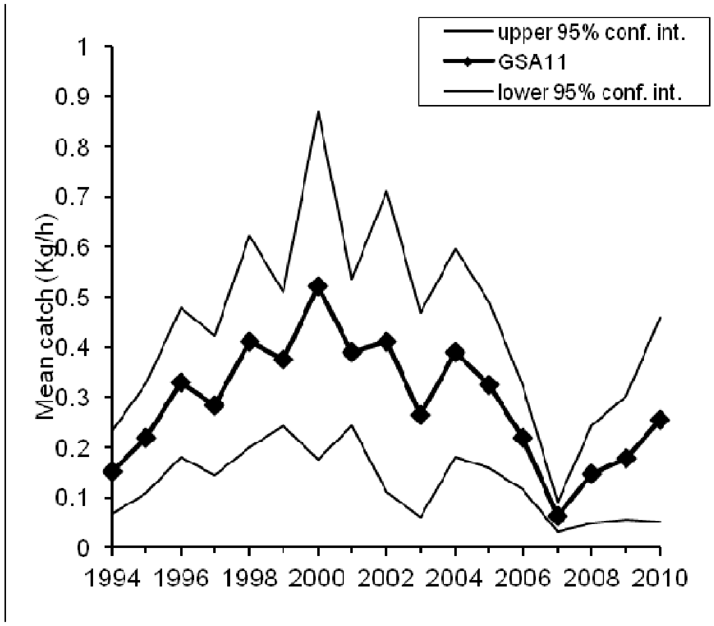


Fig. 6.18.3.1.3.1 Mean catch (kg/h) of the giant red shrimps *Aristaeomorpha foliacea* in GSA 11 (Medits data)

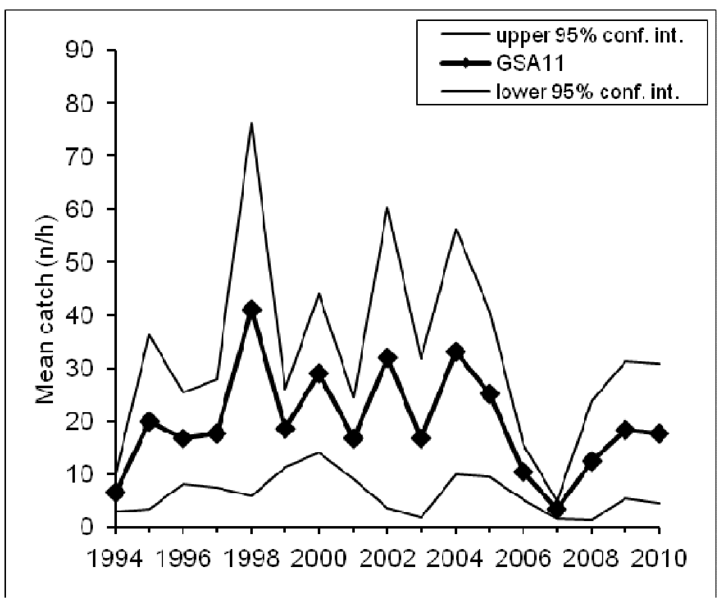


Fig. 6.18.3.1.3.2 Mean catch (n/h) of the giant red shrimps *Aristaeomorpha foliacea* in GSA 11 (Medits data)

6.18.3.1.4 Trends in abundance by length or age

MEDITS length distributions show 3 or 4 cohorts in the period 1999-2006 (Fig. 6.18.3.1.4.1). In 2007 just 2 of them can be noted and made up by very few individuals. A slow increase can be observed in the next years: in 2008 only the first cohort is clearly present, in 2009 and 2010 again 3 cohorts are found (Fig. 6.18.3.1.4.2).

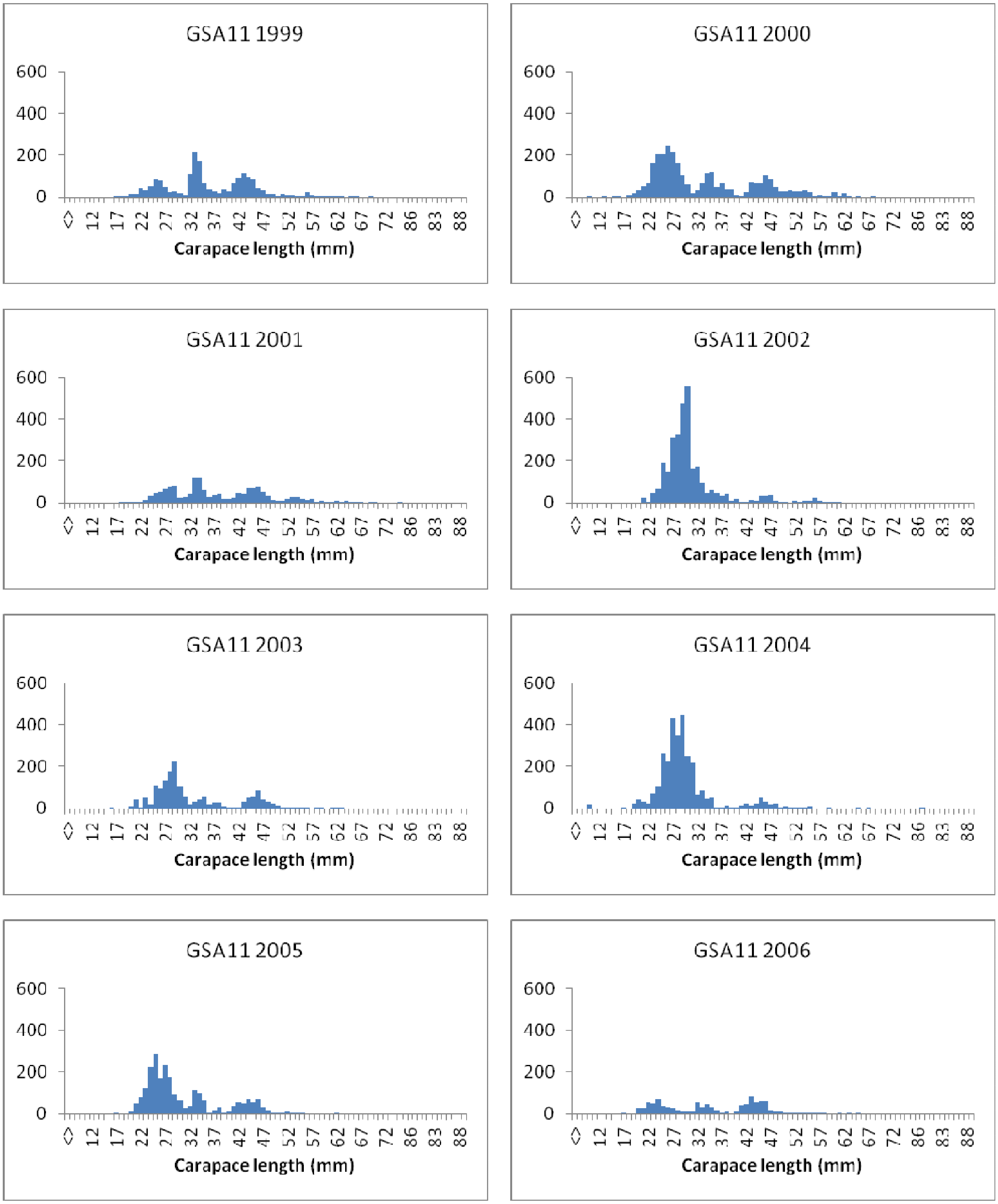


Fig. 6.18.3.1.4.1. Stratified abundance indices by size (n/km^2), 1999-2006

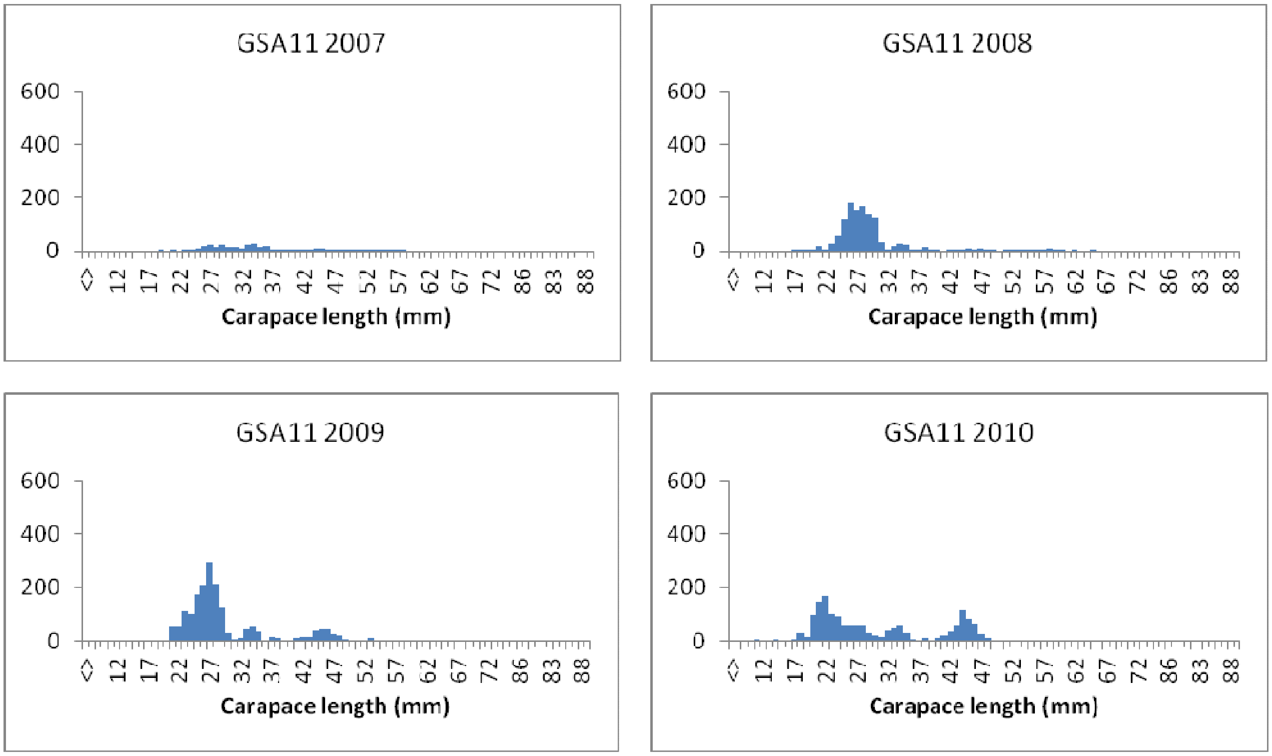


Fig. 6.18.3.1.4.1 Stratified abundance indices by size (n/km^2), 2007-2010

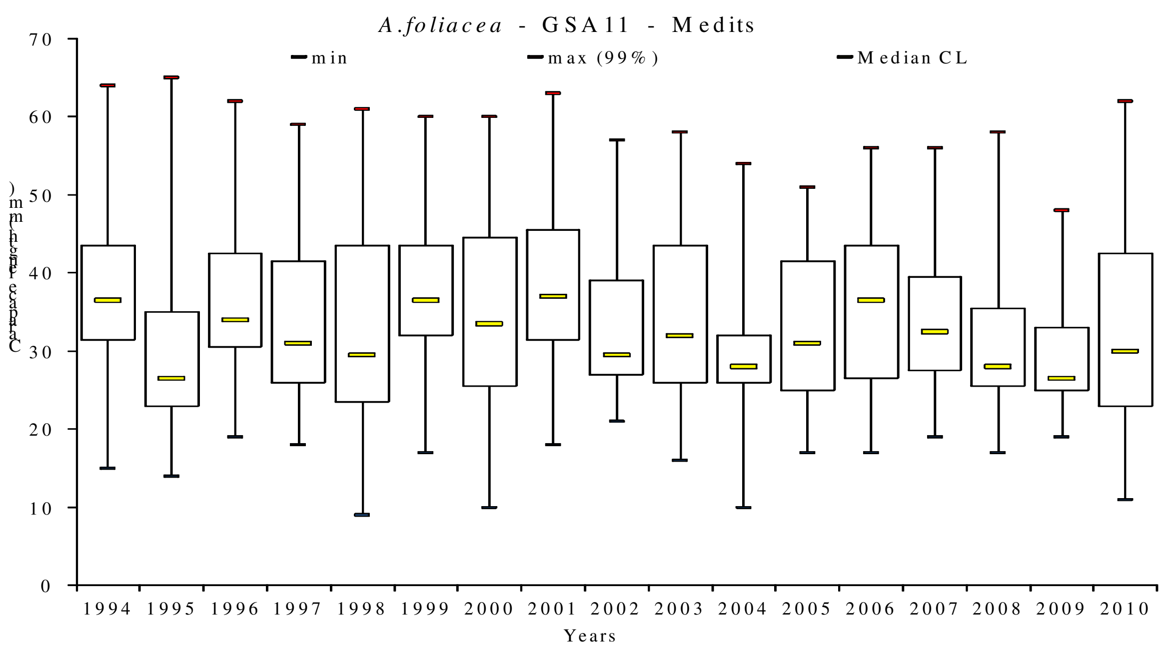


Fig. 6.18.3.1.4.2 Boxplot of the length frequency distributions of the Medits surveys.

6.18.3.1.5 Trends in growth

No analyses were conducted during EWG 11-12.

6.18.3.1.6 Trends in maturity

No analyses were conducted during EWG 11-12.

6.18.4 Assessments of historic stock parameters

6.18.4.1 Method 1: LCA

6.18.4.1.1 Justification

The pseudo-cohort analysis (VIT) was applied using DCF data from 2006 to 2010.

6.18.4.1.2 Input parameters

Data from DCF provided at EWG 11-12 gave information on the giant red shrimp landings and the respective size structure for 2006-2010. Size structures have been divided by sex using a sex ratio vector. Subsequent analyses were made separately by sex and then weighted according to the amount of the two sexes to obtain single outputs for the species.

A VPA was performed using a Length Cohort Analysis (LCA), applying the routine included in the VIT package designed by Lleonart and Salat (1992) for each year separately. Data used are reported in Tab. 6.18.4.1.2.1. and biological parameters are listed in Tab. 6.18.4.1.2.2. A natural mortality vector computed by ProdBiom was used.

Tab. 6.18.4.1.2.1. Input parameters for LCA of giant red shrimp in GSA 11.

females	males
Growth	
L_∞ =72.21	L_∞ =42.71
K = 0.5	K = 0.77
t_0 = 0	t_0 = -0.27
Length-Weight relationships	
a = 0.0017	a = 0.0007
b = 2.5857	b = 2.8339
Natural mortality	
M vector 2.46 (age 0) 0.73 (age 1) 0.44 (age 2) 0.34 (age 3) 0.29 (age 4) 0.26 (age 5) 0.24 (age 6)	M vector 2.10 (age 0) 0.63 (age 1) 0.38 (age 2) 0.29 (age 3) 0.26 (age 4) 0.23 (age 5)

Tab. 6.18.4.1.2.2 Input data for LCA Catch at length 2006-2010, GSA 11.

Carapace Length (cm)	2006	2007	2009	2010	Carapace Length (cm)	2006	2007	2009	2010
1.3	0	0	0	39932	**4.2**	207507	135446	56973	192397
1.4	0	0	0	79865	**4.3**	379925	189211	72946	193276
1.5	0	0	0	39932	**4.4**	229350	198182	79798	236201
1.6	0	0	0	39932	**4.5**	229350	135446	126145	159288
1.7	0	0	0	0	**4.6**	163821	119511	158775	159288
1.8	0	0	5320	5881	**4.7**	87371	87642	164095	129653
1.9	0	0	10640	7409	**4.8**	54607	39837	91162	48157
2.0	0	0	21280	16994	**4.9**	54607	39837	70606	48157
2.1	0	0	69842	16994	**5.0**	32764	47805	41027	22226
2.2	0	0	75162	57742	**5.1**	131057	63739	21280	55565
2.3	0	0	173149	48806	**5.2**	87371	71707	21280	51861
2.4	0	0	147232	50333	**5.3**	76450	39837	31919	85200
2.5	0	0	160101	59040	**5.4**	0	15935	26599	25931
2.6	0	0	314199	106966	**5.5**	0	0	5320	3704
2.7	0	0	411144	145308	**5.6**	32764	7967	25067	11113
2.8	0	0	217757	115903	**5.7**	0	7967	42559	14817
2.9	0	0	213983	106088	**5.8**	0	15935	47879	7409
3.0	0	0	182747	168602	**5.9**	32764	15935	3788	0
3.1	52282	44793	401884	264225	**6.0**	32764	15935	42559	11113
3.2	330888	187141	432928	505575	**6.1**	21843	15935	10640	3704
3.3	549777	313553	460224	627777	**6.2**	0	0	0	0
3.4	672697	240905	513423	647178	**6.3**	21843	15935	0	3704
3.5	279768	239901	373945	226114	**6.4**	21843	0	14428	0
3.6	115486	113489	324686	311733	**6.5**	21843	15935	26599	7409
3.7	179852	84630	154138	275379	**6.6**	0	7967	5320	3704
3.8	183339	101569	138152	243149	**6.7**	0	0	5320	0
3.9	173580	125471	106232	248611	**6.8**	0	0	10640	0
4.0	228187	111544	42559	265605	**6.9**	0	0	0	0
4.1	282794	165308	26599	244258	**7.0**	0	0	0	0

Data were age sliced by year (Fig. 6.18.4.1.2.1). Years 2005 and 2008 gave unreliable results and they were then excluded: these two years were made up mainly by males individuals, differently from the others in which females predominate (average sex ratio F/(F+M) = 0.68).

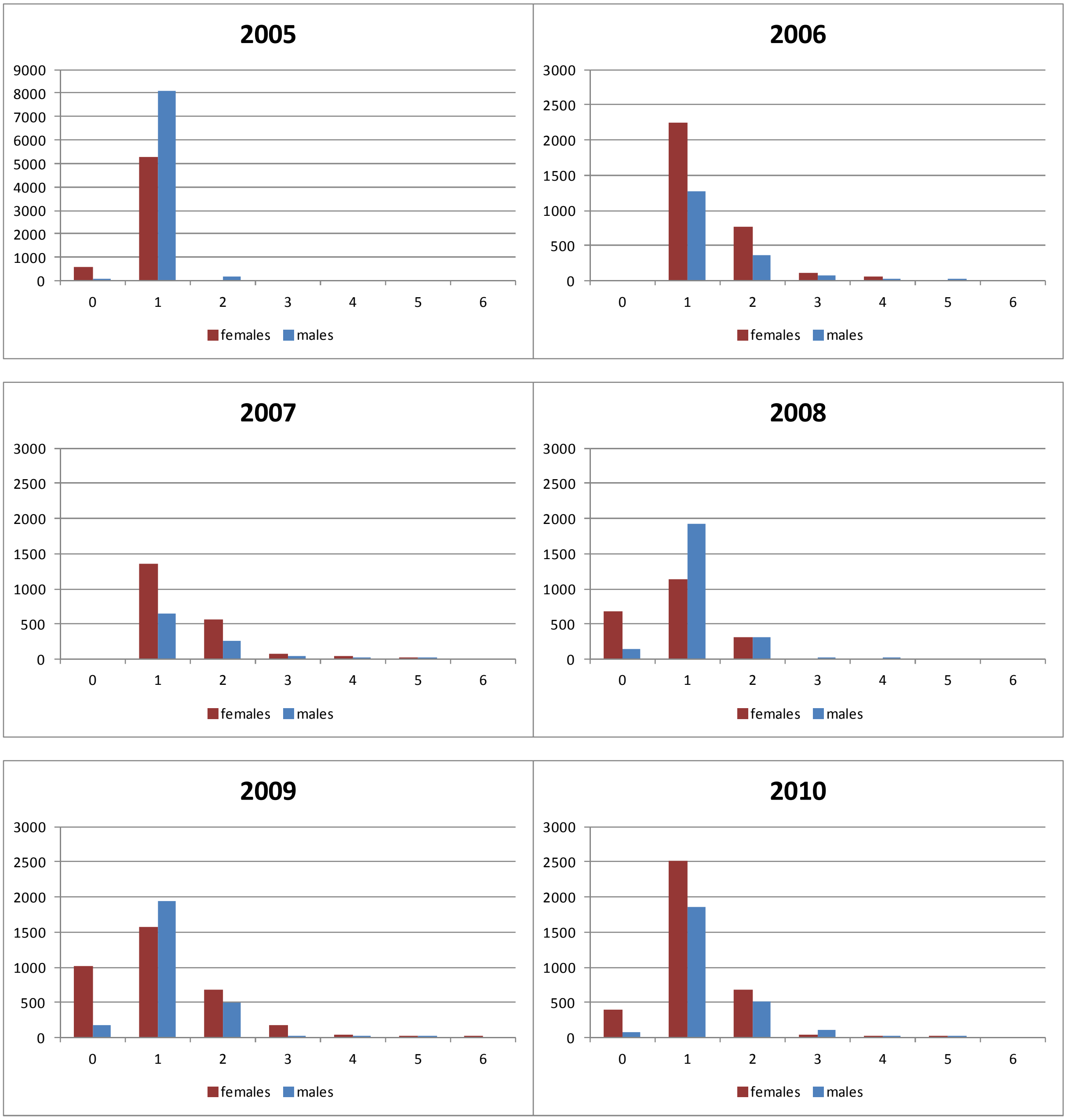


Fig. 6.18.4.1.2.1 Age frequency distribution by sex of the giant red shrimp *Aristaeomorpha foliacea* in GSA 11 from 2005 to 2010

6.18.4.1.3 Results

Giant red shrimp landings covers age class 0+ to age class 6+(Fig. 6.18.4.1.3.1). Data are mainly concentrated on age class 1+ and 2+. Few individuals of age 0+ and 3+ are also present. Fishing mortality mainly impacts age classes from 1+ to 4+ (Fig. 6.18.4.1.3.1); for this reason the following results have been averaged on them.

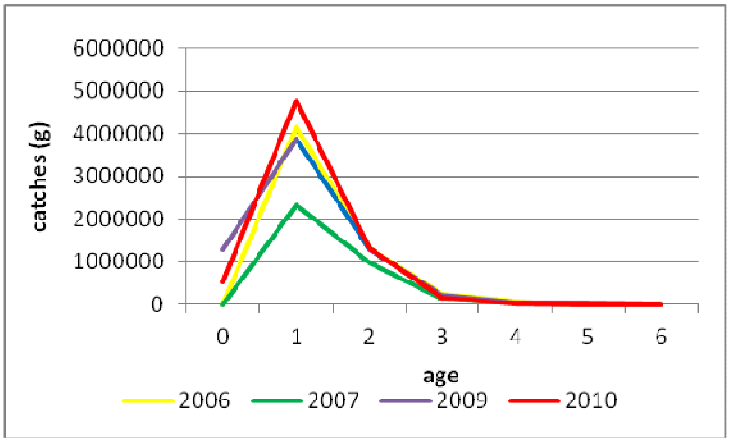


Fig. 6.18.4.1.3.1 Catch by age for *Aristaeomorpha foliacea* GSA 11

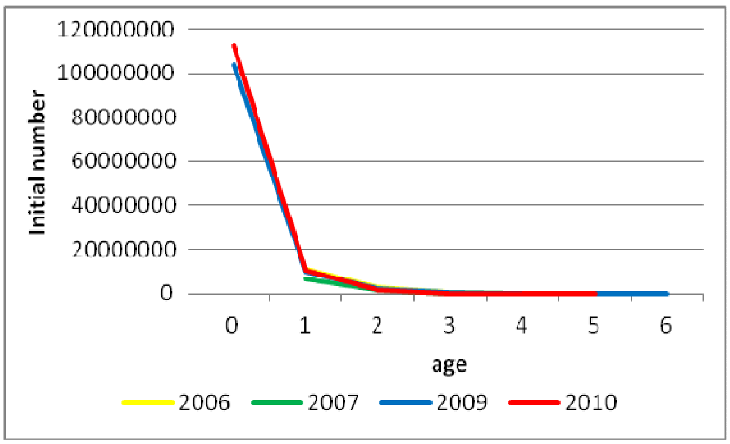


Fig. 6.18.4.1.3.2 Initial numbers for *Aristaeomorpha foliacea* GSA 11

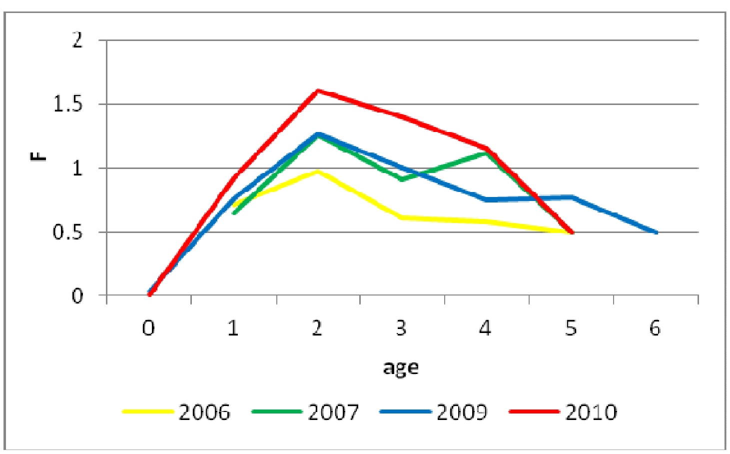


Fig. 6.18.4.1.3.3 Fishing mortality estimation for *Aristaeomorpha foliacea* in GSA 11.

6.18.5 Long term prediction

6.18.5.1 Justification

The yield per recruit from the VIT was applied.

6.18.5.1.1 Input parameters

The length frequency data from 2006, 2007, 2009 and 2010 and the biological parameters used are given in Table and Fig. 6.18.5.1.1.1.

Table 6.18.5.1.1.1 Input parameters for Y/R analysis of giant red shrimp in GSA 11.

females	males
Growth	
L_∞ =72.21	L_∞ =42.71
K = 0.5	K = 0.77
t_0 = 0	t_0 = -0.27
Length-Weight relationships	
a = 0.0017	a = 0.0007
b = 2.5857	b = 2.8339
Natural mortality	
M vector 2.46 (age 0) 0.73 (age 1) 0.44 (age 2) 0.34 (age 3) 0.29 (age 4) 0.26 (age 5) 0.24 (age 6)	M vector 2.10 (age 0) 0.63 (age 1) 0.38 (age 2) 0.29 (age 3) 0.26 (age 4) 0.23 (age 5)

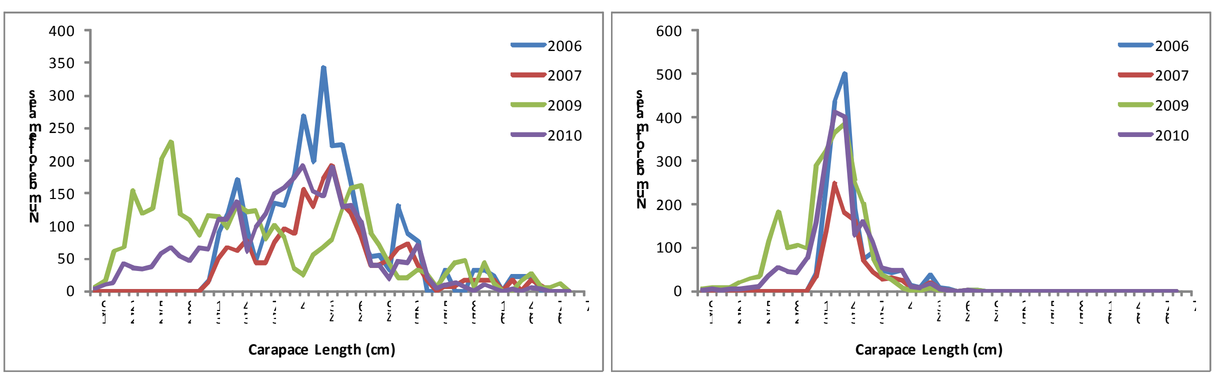


Fig. 6.18.5.1.1.1 Input data for LCA Catch at length by sex, *Aristaeomorpha foliacea* in GSA 11 (left females, right males)

Table 6.18.5.1.1.2 Input data for Y/R analysis of giant red shrimp in GSA 11.

Carapace Length (cm)	2006	2007	2009	2010	Carapace Length (cm)	2006	2007	2009	2010
1.3	0	0	0	39932	**4.2**	207507	135446	56973	192397
1.4	0	0	0	79865	**4.3**	379925	189211	72946	193276
1.5	0	0	0	39932	**4.4**	229350	198182	79798	236201
1.6	0	0	0	39932	**4.5**	229350	135446	126145	159288
1.7	0	0	0	0	**4.6**	163821	119511	158775	159288
1.8	0	0	5320	5881	**4.7**	87371	87642	164095	129653
1.9	0	0	10640	7409	**4.8**	54607	39837	91162	48157
2.0	0	0	21280	16994	**4.9**	54607	39837	70606	48157
2.1	0	0	69842	16994	**5.0**	32764	47805	41027	22226
2.2	0	0	75162	57742	**5.1**	131057	63739	21280	55565
2.3	0	0	173149	48806	**5.2**	87371	71707	21280	51861
2.4	0	0	147232	50333	**5.3**	76450	39837	31919	85200
2.5	0	0	160101	59040	**5.4**	0	15935	26599	25931
2.6	0	0	314199	106966	**5.5**	0	0	5320	3704
2.7	0	0	411144	145308	**5.6**	32764	7967	25067	11113
2.8	0	0	217757	115903	**5.7**	0	7967	42559	14817
2.9	0	0	213983	106088	**5.8**	0	15935	47879	7409
3.0	0	0	182747	168602	**5.9**	32764	15935	3788	0
3.1	52282	44793	401884	264225	**6.0**	32764	15935	42559	11113
3.2	330888	187141	432928	505575	**6.1**	21843	15935	10640	3704
3.3	549777	313553	460224	627777	**6.2**	0	0	0	0
3.4	672697	240905	513423	647178	**6.3**	21843	15935	0	3704
3.5	279768	239901	373945	226114	**6.4**	21843	0	14428	0
3.6	115486	113489	324686	311733	**6.5**	21843	15935	26599	7409
3.7	179852	84630	154138	275379	**6.6**	0	7967	5320	3704
3.8	183339	101569	138152	243149	**6.7**	0	0	5320	0
3.9	173580	125471	106232	248611	**6.8**	0	0	10640	0
4.0	228187	111544	42559	265605	**6.9**	0	0	0	0
4.1	282794	165308	26599	244258	**7.0**	0	0	0	0

6.18.5.1.2 Results

The resulting Y/R (g) and SSB/R are illustrated in Fig 6.18.5.1.2.1. All ages reference point amounts to $F_{0.1}$=0.49. F mean values are reported in Tab. 6.18.5.1.1.1. Different values obtained for years 2006-2007 vs 2009-2010 are caused by the presence in the last two years of the cohort 0+.

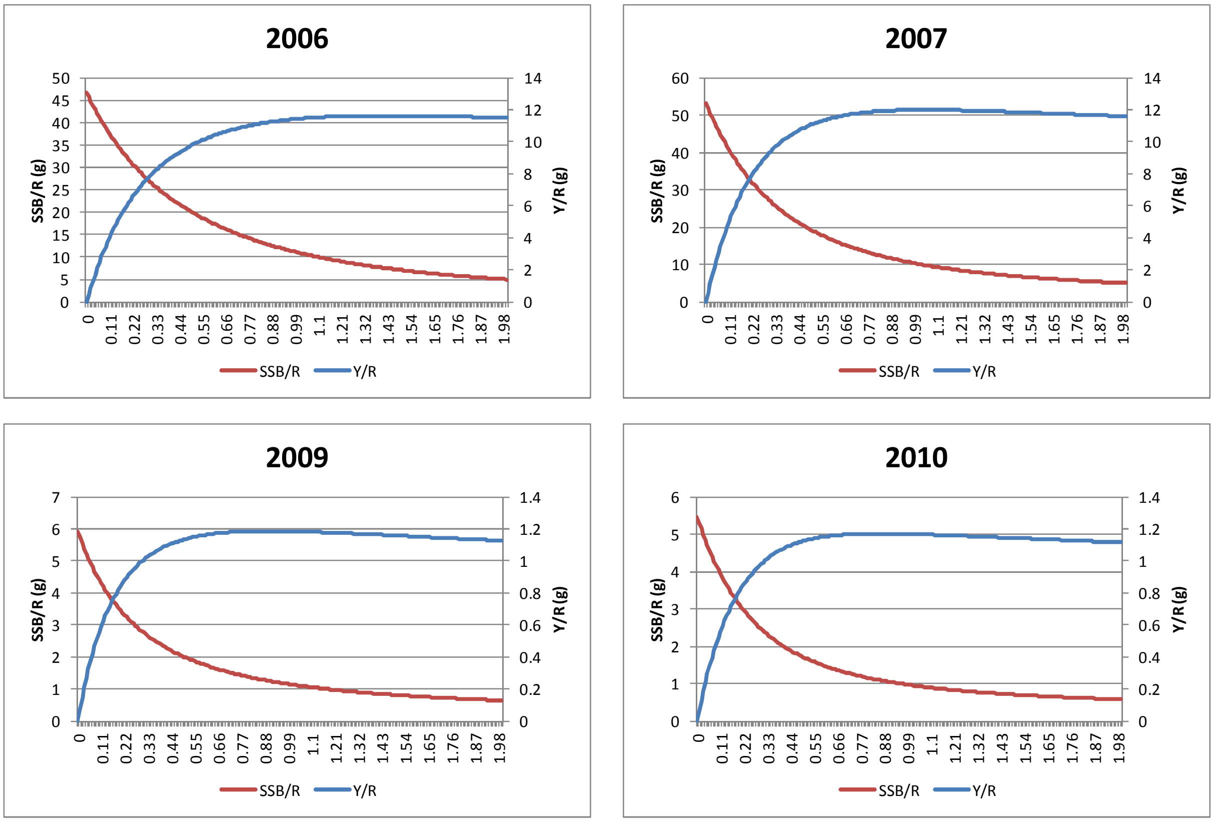


Fig. 6.18.5.1.1.1 LCA outputs: Yield per recruit and Spawning stock Biomass per recruits curves of *Aristaeomorpha foliacea* in the GSA 11

Table 6.18.5.1.1.1 Yield per recruit analysis outputs

		F	Y/R (g)	B/R (g)	SSB
2006	Virgin	0.00	0.00	55.83	50.47
	$F_{0.1}$	0.53	11.82	20.34	16.34
	$F_{c\ 1\text{-}4}$	0.72	12.34	16.32	12.57
	F_{max}	1.03	12.61	11.62	8.36
2007	Virgin	0.00	0.00	64.77	59.44
	$F_{0.1}$	0.50	12.18	25.08	20.66
	$F_{c\ 1\text{-}4}$	0.98	13.08	14.89	11.11
	F_{max}	1.12	13.10	14.48	10.72
2009	Virgin	0.00	0.00	7.09	6.17
	$F_{0.1}$	0.41	1.11	3.15	2.31
	$F_{c\ 1\text{-}4}$	0.95	1.20	1.96	1.19
	F_{max}	0.86	1.20	2.09	1.31
2010	Virgin	0.00	0.00	6.53	5.61
	$F_{0.1}$	0.52	1.11	2.81	1.97
	$F_{c\ 1\text{-}4}$	1.28	1.18	1.64	0.90
	F_{max}	1.15	1.20	1.85	1.08

Table 6.18.5.1.1.2 F Mean values

	Mean values
$F_{0.1}$	0.49
$F_{c\ 1\text{-}4}$	0.98
F_{max}	1.04

6.18.6 Data quality

Medits survey data were available from 1994 to 2010 and no differences in abundance and biomass indexes were recognized between EWG 11-05 and EWG 11-12.

Landings data by length in EWG 11-05 were available only for 2009 by Metier (OTB-MDD). In EWG 11-12 the same data are available from 2005 to 2010 by Gear. Obviously, due to the different expansion of data, the length frequency for 2009 in EWG 10-05 and EWG 11-12 are not the same. Instead, total landings for 2009 (OTB-MDD+OTB-DWS) in EWG 11-05 are exactly the same of EWG 11-12 (GEAR=OTB).

6.18.7 Scientific advice

6.18.7.1 Short term considerations

6.18.7.1.1 State of the stock size

Stock assessment has been computed by Length Cohort Analysis (VIT software) using DCF data of landings at age (2006-2010). Medits survey indices show a variable pattern of abundance (n/h) and biomass (kg/h) without a clear trend. Since no precautionary level for the stock of the giant red shrimp in GSA 11 was proposed, EWG 11-12 cannot evaluate the stock status in relation to the precautionary approach.

6.18.7.1.2 State of recruitment

Medits length frequency data did not show any particular recruitment event. In 2006 and 2007 however a reduction in the amount of recruits can be observed. This reduction can be noted by length at age of commercial landings too for the same years: in fact age 0+ class was not present.

6.18.7.1.3 State of exploitation

EWG 11-12 proposes F0.1≤0.49 as limit management reference point consistent with high long term yields (F_{MSY} proxy). Average $F_{current1\text{-}4}$ estimated using Length Cohort analysis (0.98) exceeds $F_{0.1}$. The stock would not be able to sustain the current level of fishing effort with this level of exploitation. Thus EWG 11-12 considers the stock to be subject to overfishing and that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

6.19 Stock assessment of red mullet in GSAs 15 and 16

6.19.1 Stock identification and biological features

6.19.1.1 Stock Identification

Levi et al., (1992), comparing growth curve of *M. barbatus* in the Mediterranean, found significant differences between red mullet growth in Sicilian side of Strait of Sicily (GSA 15 and 16) and Gulf of Gabes (GSA 14).

Other evidences supporting the existence of separate stocks of red mullets in Central Mediterranean comes from parasitological observations. A large infestation by a trematode of the genus *Stephanostomum* seriously affected the red mullet fishery in the Tunisian waters for several months in 1990. No such occurrence was noted in the fish landed at the Sicilian base-ports of the strait of Sicily (Levi et al., 1993).

Other hypothesis on separation of stocks units in the strait of Sicily, was proposed by Levi et al. (1995), on the basis of independence of water masses and circulation system in the Sicilian and African border of the Strait of Sicily.

Since the red mullet is a typical coastal resources, the peculiarity of the Strait of Sicily (two shelfs - the European and the African ones-separated by narrow deep bottoms) supports the hypothesis of the existence of different subpopulations in the area.

6.19.1.2 Growth

The Von Bertalanffy Growth Function parameters by sex available for different areas of the Strait of Sicily are reported in Table 6.19.1.2.1.

Table 6.19.1.2.1 Von Bertalanffy growth function parameters of *M. barbatus* in the Strait of Sicily (n.a. – not available).

Author	Area	Females			Males			Combined sexes			Remarks
		L_∞	K	t_0	L_∞	K	t_0	L_∞	K	t_0	
Gharbi & Ktari 1981	14	20.46	0.50	-0.04	18.09	0.50	-0.18	-	-	-	Scales readings
Andaloro & Prestipino G., 1985	16	24.55	0.23	-2.01	23.29	0.16	-2.84	-	-	-	Otoliths readings
Levi et al., 1992	15 & 16	-	-	-	-	-	-	27.62	0.15	-2.68	Otoliths readings
Djabali et al., 1990	4	-	-	-	-	-	-	29.65	0.21	n.a.	n.a.
Ben Meriem et al., 1995	n.a.	-	-	-	-	-	-	26.70	0.51	n.a.	n.a..
IRMA-CNR, 1999	15 & 16	23.20	0.64	-0.55	19.91	0.67	-0.66	-	-	-	LFD analysis
SAMED, 2002	15 & 16	26.00	0.62	-0.20	20.20	0.64	-0.20	-	-	-	Otoliths readings
CNR-IAMC, 2007	16	26.50	0.26	-1.24	20.67	0.49	-0.62	-	-	-	Otoliths readings
CNR – IAMC, 2010	15 & 16	23.61	0.45	-0.80	20.16	0.57	-0.80	-	-	-	Otoliths readings

6.19.1.3 Maturity

Red mullet reproduction in the GSA 13 occurs near the coast, from May to June-July (Gharbi & Ktari, 1981; Cherif et al., 2007). According to Levi (1991) spawning in GSA 15 and 16 takes place in May.

The estimation of length at first maturity for the Strait of Sicily (Tab. 6.19.1.3.1.) resulted fairly close to what is found in the available literature on the Central Mediterranean (Voliani, 1999).

Table 6.19.1.3.1 – Length at 50% maturity ($L_{50\%}$) and curvature parameters of ogive at maturity by sex of *M. barbatus* in the Strait of Sicily (n.a.–not available).

Author	GSA	Females		Males	
		L50%	g	L50%	g
Gharbi & Ktari, 1981	13	15-16	n.a.	14	n.a.
SAMED, 2002	15&16	15.5	n.a.	n.a.	n.a.
Gangitano S. (pers. comm.)	15&16	14.9	1.18	n.a.	n.a.
Cherif et al., 2007	12	13.9	n.a.	13.9	n.a.

6.19.2 Fisheries

6.19.2.1 General description of fisheries

Red mullet (*M. barbatus*) is one of the main demersal resources of the coastal areas in the Mediterranean, fished by otter trawl and, in minor quantities, by trammel-nets, together with other several species (Voliani, 1999). Red Mullet is caught together with other important species such as *Mullus surmuletus, Merluccius merluccius, Pagellus sp., Uranoscopus scaber, Raja sp., Trachinus sp., Octopus vulgaris, Sepia officinalis, Eledone sp.* and *Lophius sp.*.

In GSA 15 and 16 red mullet is caught almost exclusively by inshore trawlers operating on shelf fishing-grounds of GSA 15 and 16, i.e. the Malta and Adventure Banks.

6.19.2.2 Management regulations applicable in 2010 and 2011

At present there are no formal management objectives for red mullet fisheries in the Strait of Sicily. As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area closures) and fish size limits.

Since 1989 no new fishing licenses were assigned in Italy and a progressive reduction of fleet capacity is occurring.

The adoption of the fishing closure of 30-45 days per year since late eighties have should contributed to reduce the fishing effort on demersal resources off the Sicilian coast. However this measure for many years had low efficacy in Sicily because the period of stopping trawling was not chosen to reduce fishing mortality on juveniles (late summer-early autumn).

Coupling the trawling ban in autumn, when the young red mullets move deeper, with the existing prohibition of trawling within three nautical miles from the coast, where the fish recruit in summer (Voliani, 1999), has proved to produce a remarkable increase of the stock size (Relini et al., 1996; Pipitone et al., 2000). Since 2008 the seasonal trawling ban for Sicilian trawlers was done in September–October contributing to improve the stock status of red mullet.

The European Commission regulation 1967/2006 fixed a minimum mesh size of 40 mm square or 50 mm diamond for bottom trawling of EU fishing vessels after July 2008, however derogations were possible until 2010. The regulation CE 27 June 1994 n°1626 of the European Union fixed the minimum marketable size of *Mullus* sp. at 11 cm total length. This minimum length, confirmed by the new regulation CE 1967 of 21 December 2006, is valid for both Italian and Maltese fishing boats operating in the area.

It must be to outline the existence in the Strait of Sicily of the Maltese Management Fishing Zone (MMFZ) extending up to 25 nautical miles from baselines around the Maltese islands, in which fisheries are specifically managed on the basis of the control of the fleet capacity.

The access of Community vessels to the waters and resources in the MMFZ is regulated as follows:

(a) fishing within the management zone is limited to fishing vessels smaller than 12 metres overall length using other than towed gears and ;

(b) the total fishing effort of those vessels, expressed in terms of the overall fishing capacity, does not exceed the average level observed in 2000-2001 that corresponds to 1 950 vessels with an overall engine power and tonnage of 83 000 kW and 4 035 GT respectively.

Trawlers not exceeding an overall length of 24 metres are authorised to fish in certain areas within the management zone. The overall fishing capacity of the trawlers allowed to operate in the management zone must not exceed the ceiling of 4 800 kW and the fishing capacity of any trawler authorised to operate at a depth of less than 200 metres must not exceed 185 kW.

Trawlers fishing in the management zone hold a special fishing permit in accordance with Article 7 of Regulation (EC) No 1627/94 and are included in a list containing their external marking and vessel's Community fleet register number (CFR) to be provided to the Commission annually by the Member States concerned.

6.19.2.3 Catches

6.19.2.3.1 Landings

According to Andreoli et al., (1995), the estimated yield of *Mullus* sp. between April 1985 and March 1986 was about 1100 tons; the next year it amounted 630 tons. Considering that overall yield was about 9670 tons in the first year and 8050 tons in the second one, *Mullus* sp. landings represented about 8-11% of total yield in the area. This landing is sold and recorded on coastal production markets, unlike the fish caught by distant water trawlers.

Landings data were reported to STECF EWG 11-12 through the Data Collection Framework. Annual landings decreased from 1,626 t in 2004 to 770 t in 2010. (Tab. 6.19.2.3.1.1). Demersal otter trawlers dominate the landings by far. In 2005-2010 Maltese landings on average contribued 0.7% to the total landings made by the Maltese and Italian fleets using bottom otter trawls and trammel nets.

Table 6.19.2.3.1.1 Annual landings (t) by fishing technique as reported to STECF EWG 11-12 through the DCF data call.

Species	Area	Country	FT_LVL4	2005	2006	2007	2008	2009	2010
MUT	16	ITA	GTR	29	39	37	20	13	0
MUT	16	ITA	OTB	1377	1084	1343	1157	787	757
MUT	16	Total ITA	n/a	1406	1123	1380	1177	801	757
MUT	15	MLT	GTR	1.01	0.75	0.50	0.42	0.35	1.02
MUT	15	MLT	OTB	1.9	7.0	0.5	13.8	8.9	12.3
MUT	15	Total MLT	n/a	3	8	1	14	9	13
MUT	15&16	ITA&MLT	Total	1409	1131	1381	1191	810	770

6.19.2.3.2 Discards

The discarded fraction of red mullet varies with season and typology of fisheries. Considering the Sicilian fleet in the late ninenties, trawlers fishing near coast have the lower fraction of discard, as they land all catches. In summer the smallest landed *M. barbatus* may be 7-8 cm total length. The biggest trawlers, carrying out 15 – 25 day-trips and fishing far from the coast, discard red mullet smaller than about 12 cm TL. This discard may be important during the summer and autumn. The high discard rate is due to the necessity to use the space in the cold cellar almost exclusively for high prised crustaceans. In this situation the first modal group (9-10 cm) in the catches is totally discarded (Anon., 2000) (tab. 6.19.2.3.2.1).

Table 6.19.2.3.2.1 – Yearly modal length in cm of discarded fraction and landings of red mullet in typical inshore (Porto Palo- South eastern Sicily) and distant (Mazara del Vallo - South western Sicily) Sicilian trawling fisheries (from Anon., 2000).

	Modal length (cm)	
	discards	landings
Inshore fisheries	No discard	16
Distant fisheries	9 and 15	18-19

Recent studies on the discarded fraction of trawlers in GSA 16 during 2006 given a length at 50% discard ranging between 11.3 (autumn) and 12.0 (spring) cm TL (Gancitano V., pers. comm.).

The most recent information on discard by size concerns trawlers lower than 24 m LOA in 2009 (fig. 6.19.2.3.2.1), allowing to estimate a length at 50% discard around 11-12 cm TL.

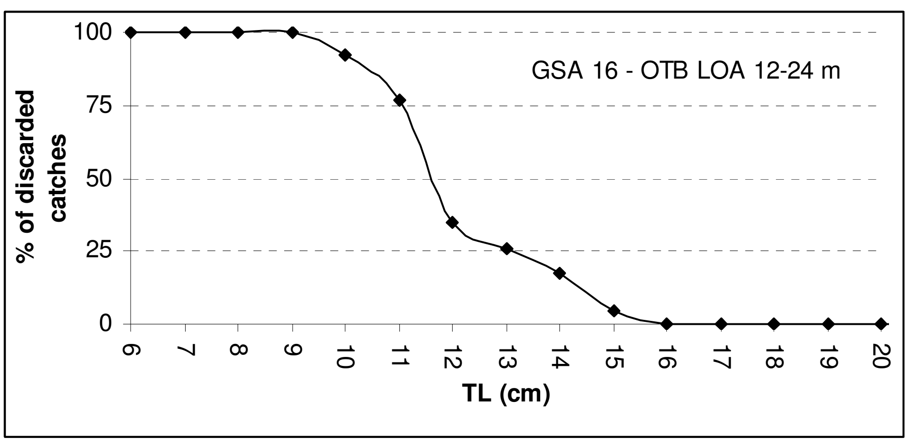


Fig. 6.19.2.3.2.1 Length at discard of *Mullus barbatus* of trawlers 12-24 m LOA in 2009 in GSA 16, expressed as % of discarded on catch. The length at 50% discard was around 11-12 cm TL.

Discards data, collected within the DCF, were reported for 2006 to 2010. The discards concerns almost exclusively the trawlers smaller than 24 m LOA.

Tab. 5.24.2.3.2.1 Discards data by fishing technique in GSA 16.

Species	Area	Country	FT_LVL4	2006	2007	2008	2009	2010
MUT	16	ITA	OTB	94	117	101	186	n.a.

6.19.2.4 Fishing effort

The effort by main fishing technique and segment deployed in GSA 15 & 16, keeping separate the Italian and Maltese fleet, as reported to STECF EWG 11-12 through the DCF data call is showed in fig. 6.19.2.4.1. The segment of the Italian demersal otter trawl reveals a 20% decrease for vessels larger than 24m in 2008-2010 compared to 2004-2007. A decreasing pattern was also clear for the Italian boats equipped with trammel-nets.

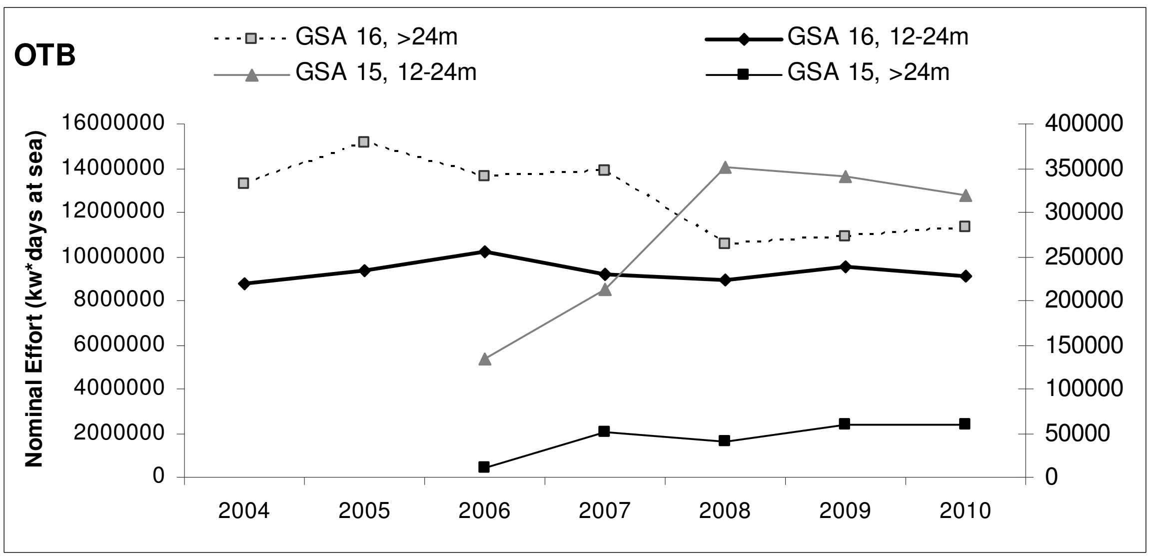


Fig. 6.19.2.4.1.. Nominal effort (kW*days at sea) trends of trawlers (OTB) by segments in GSA 15 (left) & 16 (right), 2004-2010.

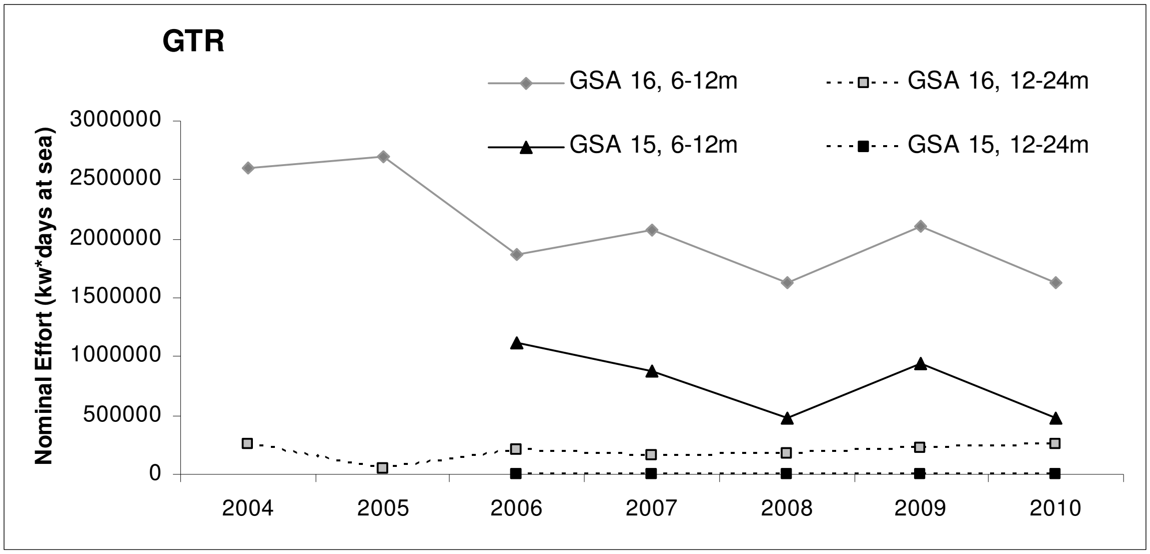


Fig. 6.19.2.4.2. Nominal effort (kW*days at sea) trends of artisanal fisheries (GRT- trammel nets) segments in GSA 15 & 16, 2004-2010.

6.19.3 Scientific surveys

6.19.3.1 Medits

6.19.3.1.1 Methods

Based on the DCF data call, abundance and biomass indices were recalculated. In GSA 15 and 16 the following number of hauls was reported per depth stratum (s. Tab. 6.19.3.1.1.1).

Tab. 6.19.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 1994-2010.

Depth (m)	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
10-50	4	4	4	4	4	4	4	4	7
50-100	8	8	8	8	8	8	7	8	11
100-200	4	4	4	4	5	5	6	5	10
200-500	10	11	11	12	11	11	11	11	19
500-800	10	14	14	13	14	14	14	14	19
Depth (m)	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	
10-50	7	7	10	10	11	11	11	11	
50-100	12	12	20	22	23	23	23	23	
100-200	8	9	18	19	21	21	21	21	
200-500	18	19	28	31	27	27	27	27	
500-800	20	19	32	33	38	38	38	38	

Tab. 6.19.3.1.1.2. Number of hauls per year and depth stratum in GSA 15, 2002-2010.

Depth (m)	2002	2003	2004	2005	2006	2007	2008	2009	2010
10-50	1	1	2	1	1	0	0	0	0
50-100	5	5	4	5	5	12	6	6	6
100-200	13	13	13	13	13	12	13	14	14
200-500	10	10	10	9	10	4	9	10	10
500-800	16	16	15	17	16	17	17	15	15

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.19.3.1.2 Geographical distribution patterns

As indicated by Garofalo et al. (2004), two major and clearly separate spawning areas exist in the Northern side of the Strait of Sicily (GSA 15 and 16). They are located over the Adventure Bank, off the South–Western coast of Sicily (GSA 16) and over the Malta Bank, between Sicily and the Maltese Island (GSA 15), respectively, in the outer shelf (100-150m) (fig. 6.19.3.1.2.1).

Recent researches on the Marine Protected Area of Castellammare del Golfo (north-western coasts of Sicily – GSA 10), where trawling has been forbidden since 1990, have shown that the oldest spawners prefer deeper bottom (100<p<200m), while the young ones are found in shallower areas (p<50m) (Fiorentino et al., 2008).

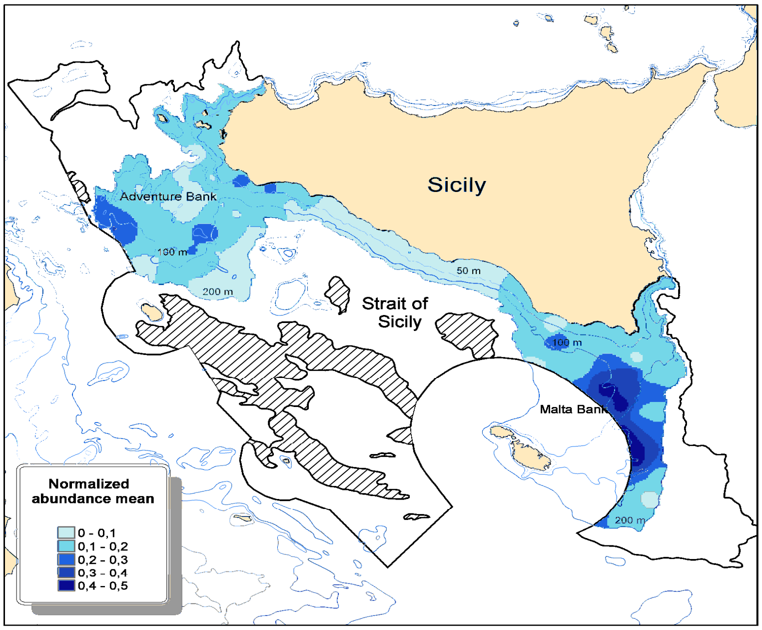
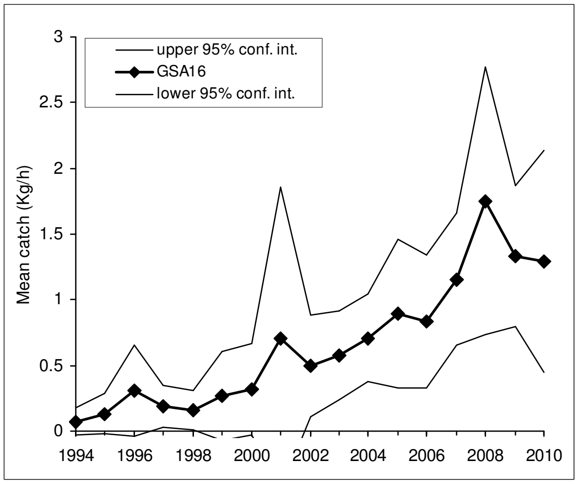


Fig. 6.19.3.1.2.1 – Map of the average distribution pattern of *M. barbatus* spawners based on scientific survey data. The contour of the overall study area and the water depth of more than 800 m (black shaded) are also shown (GSA 15 and 16) (from Garofalo et al., 2004).

6.19.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 16 was derived from the international survey Medits. Figure 6.19.3.1.3.1 displays the estimated trend in red mullet abundance and biomass in GSA 15 and Figure 6.19.3.1.1.2 displays the estimated trend in red mullet abundance and biomass in GSA 16..

The estimated abundance and biomass indices reveal a significant increasing trend since 1994.



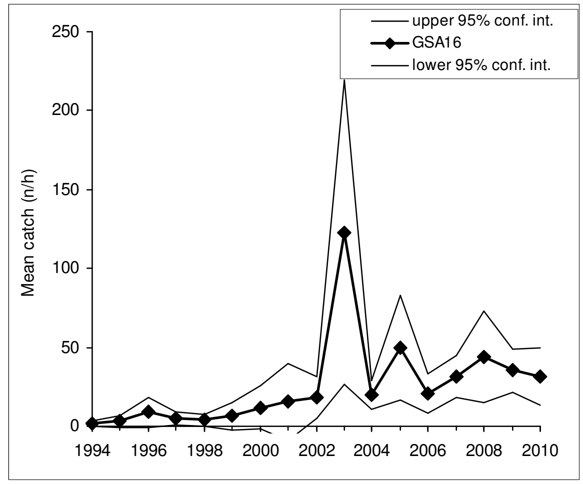
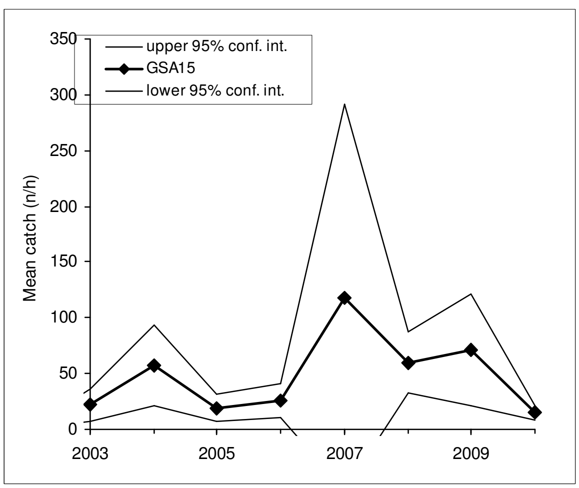


Fig. 6.19.3.1.3.1 Abundance and biomass indices of red mullet in GSA 16.



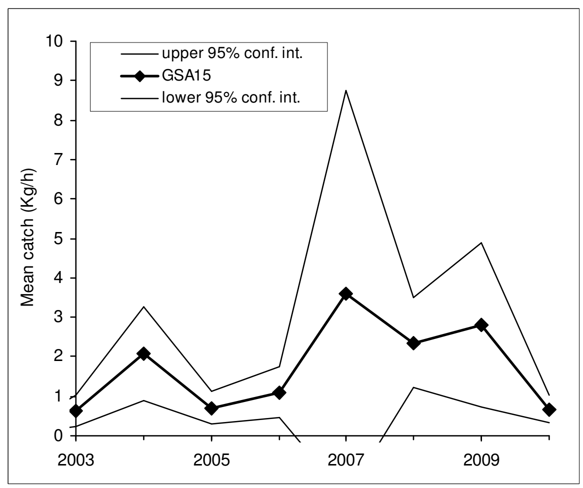


Fig. 6.19.3.1.3.2 Abundance and biomass indices of red mullet in GSA 15.

Biomass indices derived from scientific surveys in spring-summer (MEDITS), which is representative of SSB, show a clear increasing trend of spawners' abundance since early 1990s.

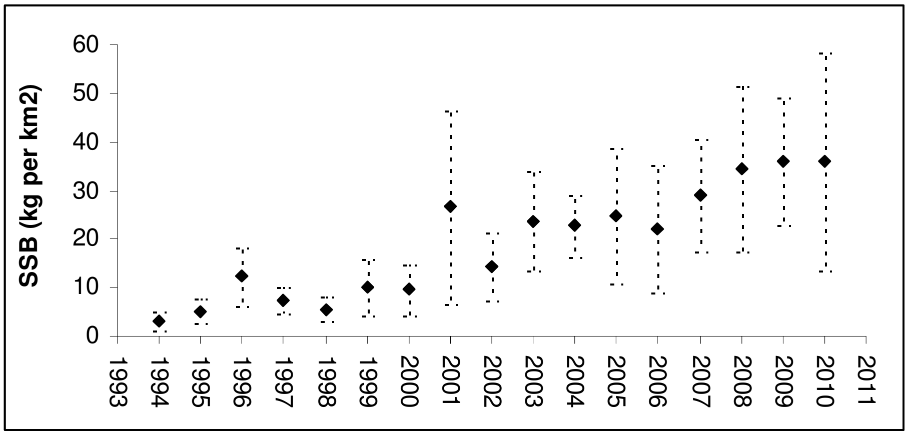


Fig. 6.19.3.1.3.3 Biomass indices derived from scientific surveys in spring-summer (MEDITS). Almost the individuals is mature in this season being representative of SSB at sea.

The time series of recruitment indices from trawl surveys in autumn (GRUND surveys) carried out in GSA 16 (individuals smaller than 11 mm CL) showed an increasing trend of recruitment, with high value in 2003-2004 and 2007-2008, years affected by strong positive anomalies of the seawater surface temperature (B. Patti personal communication).

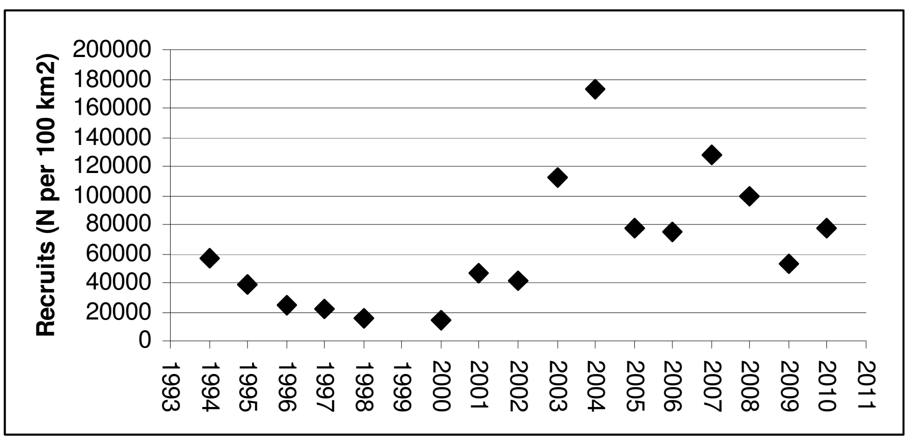


Fig. 6.19.3.1.3.4 Recruit indices derived from scientific surveys in autumn (GRUND). Since the GRUND surveys was not carried out in some years (1999 and 2007) and was suspended since 2009, lacking data was derived from LCA strength of recruitment estimates.

6.19.3.1.4 Trends in abundance by length or age

The following Fig. 6.19.3.1.4.1 and 2 display the stratified abundance indices by size of GSA 15 in 2003-2010 and 16 in 1994-2010 .

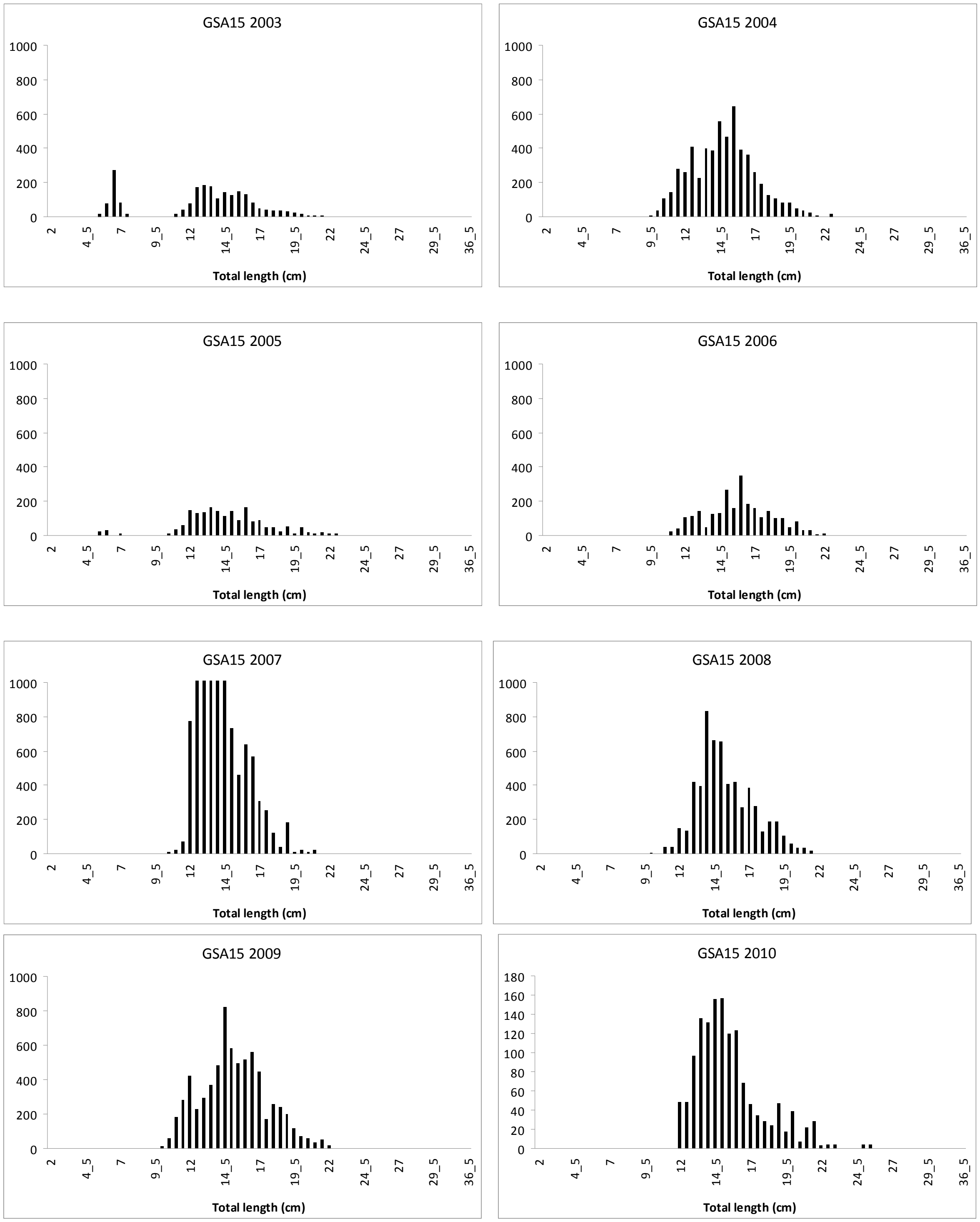


Fig. 6.19.3.1.4.1 Stratified abundance indices by size in GSA 15, 2003-2010.

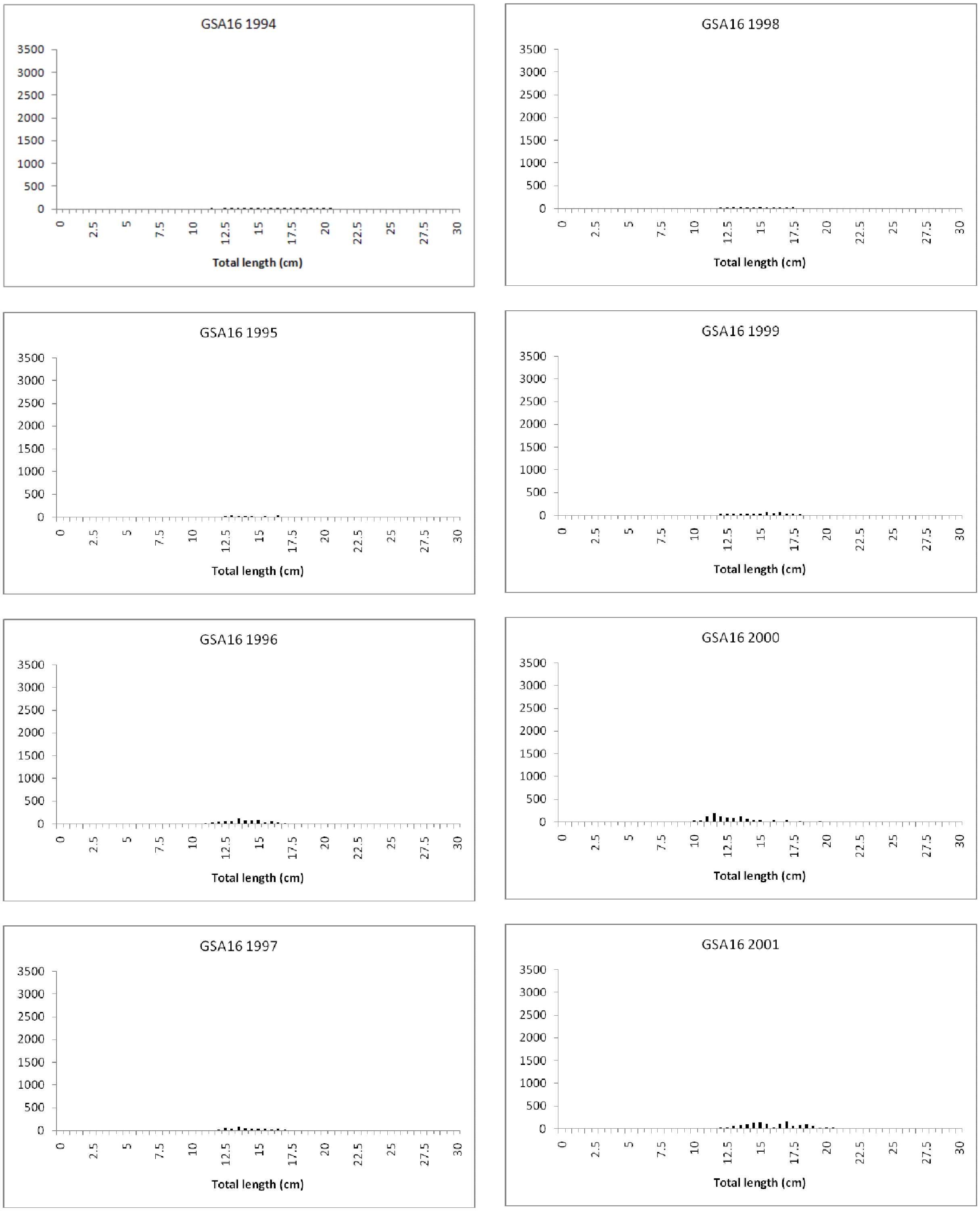
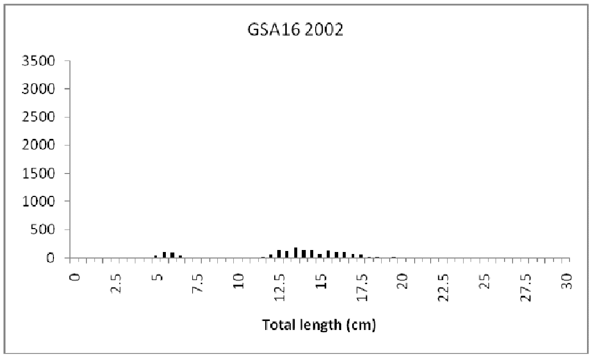
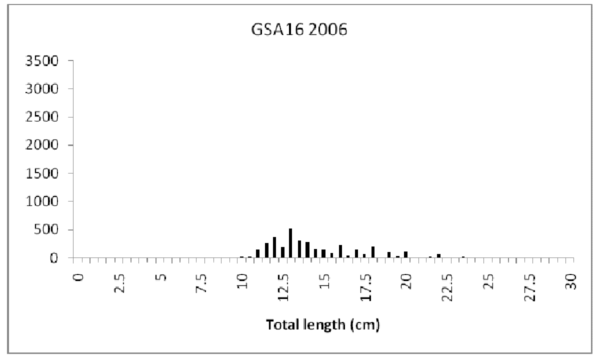
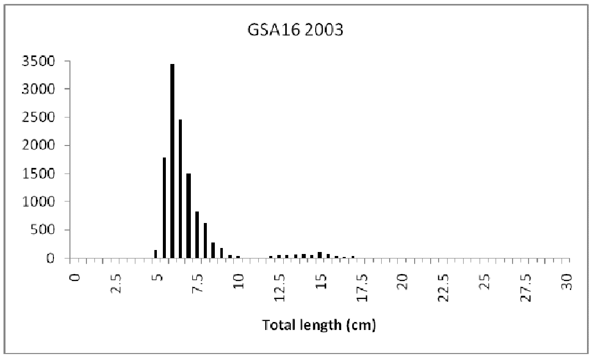


Fig. 6.19.3.1.4.2 Stratified abundance indices by size in GSA 16, 1994-2001.


GSA16 2002
3500
3000
2500
2000
1500
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA16 2006
3500
3000
2500
2000
1500
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA16 2003
3500
3000
2500
2000
1500
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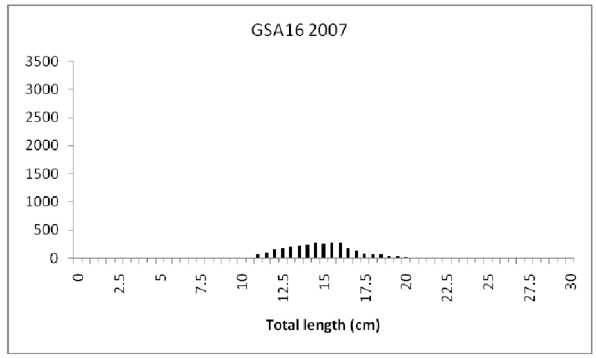
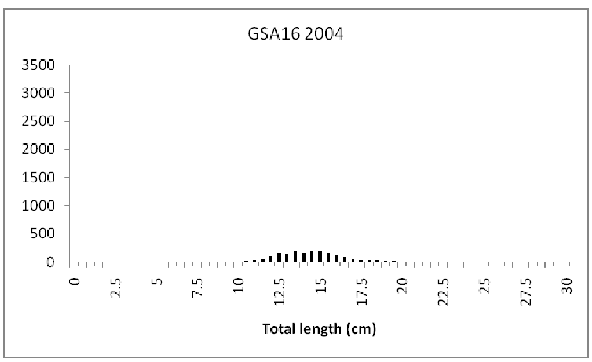
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA16 2007
3500
3000
2500
2000
1500
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA16 2004
3500
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2000
1500
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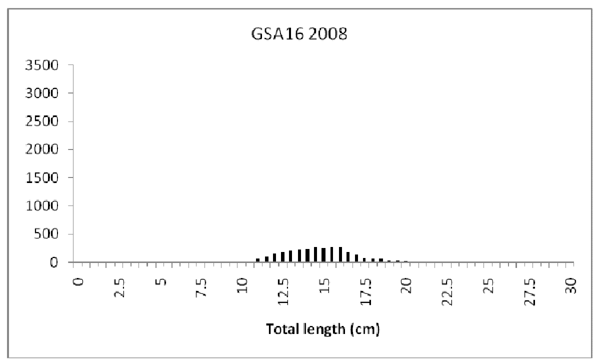
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA16 2008
3500
3000
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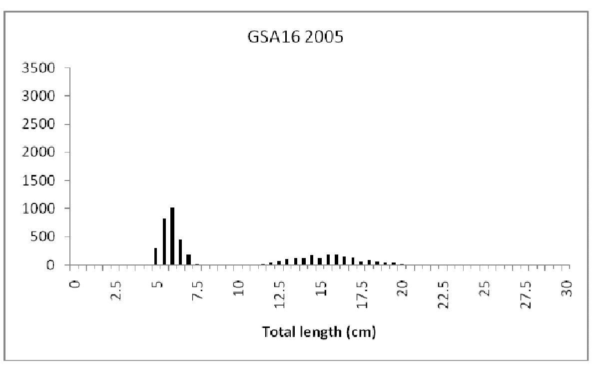
1000
500
0
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA16 2005
3500
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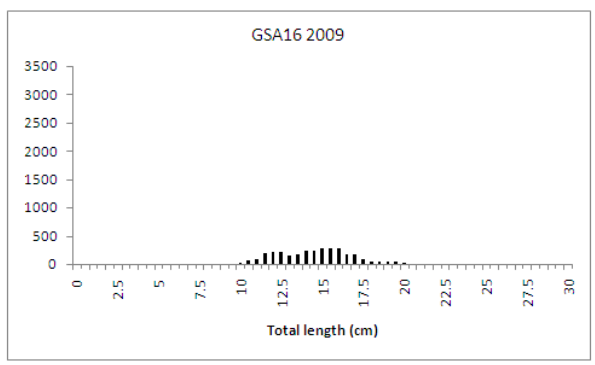
0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)


GSA16 2009
3500
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500
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0 2.5 5 7.5 10 12.5 15 17.5 20 22.5 25 27.5 30
Total length (cm)

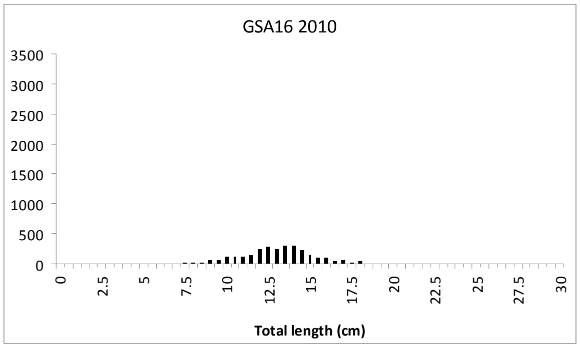


Fig. 6.19.3.1.4.3 Stratified abundance indices by size in GSA 16, 2002-2010.

6.19.3.1.5 Trends in growth

No analyses were conducted during STECF EWG 11-12.

6.19.3.1.6 Trends in maturity

No analyses were conducted during STECF EWG 11-12.

6.19.4 Assessment of historic stock parameters

Levi et al. (1993) assessed exploitation state of *M. barbatus* of Sicilian side of Strait of Sicily (GSA 15 & 16), by using analytical monospecific model based on trawl surveys data. According to the Beverton and Holt relative yield per recruit model, the exploitation rate (E=F/Z) in 1985/87, ranging between 0.66 and 0.73, was higher than E_{max} (=0.59) (fig. 6.19.4.1).

The stock simulation according to a Thompson and Bell model, with fishing mortality (F) from 0.5 to 2 times the current value and keeping gear selectivity constant, showed that the long term yield does not change significantly varying fishing effort (fig. 6.19.4.2).

However the picture is different in terms of economic gain since the potential income doubled if fishing mortality was reduced to a 40% of current value. Further increase of yield and economic value in long-term scenario could derive by changing from 32 to 40 mm.

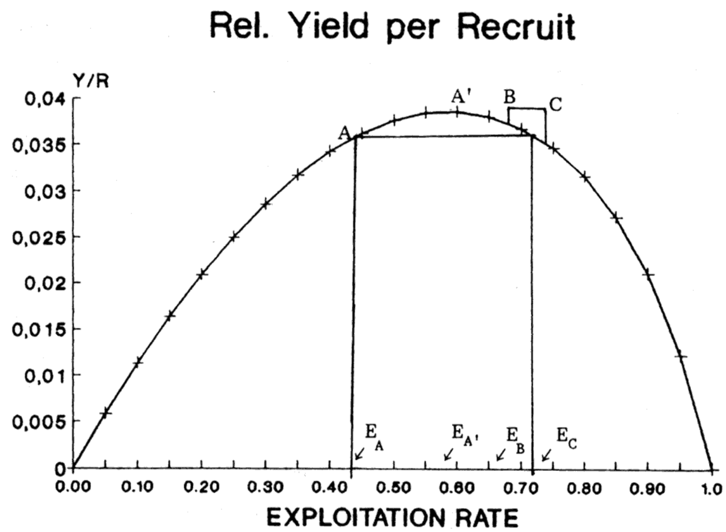


Fig. 6.19.4.1 – Beverton and Holt relative yield per recruit. *Mullus barbatus.* L∞ = 27.62 cm; M/K= 1.61. B-C 1985/86 situation; A' maximum yield per recruit; Optima: $E_{max.}$= 0.59; $E_{0.1}$= 0.56; $E_{0.5}$=0.31 (from Levi et al., 1993).

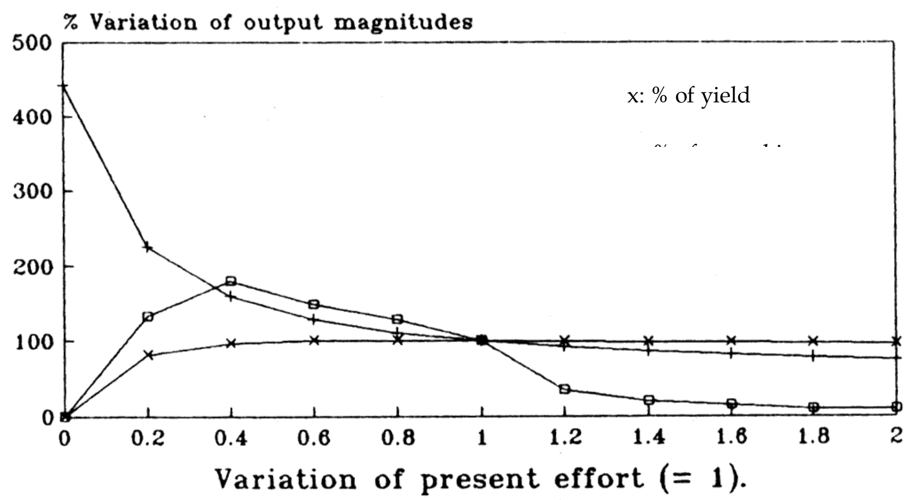


Fig. 6.19.4.2 – Thompson and Bell analysis for 1985/86 fishing pattern. *Y*, %variation of output magnitudes; *X*, variations of present effort (=1) (from Levi et al., 1993).

Comparable results were obtained by stock assessments carried out in the framework of the GRUND (Italian group on evaluation of demersal resources) trawl surveys in the late nineties (tab. 4) (IRMA-CNR, 1999).

Table 6.19.4.1 – Simulation of long - term variation in yield per recruit (Y/R) and income per recruit (£/R) of Red Mullet in GSA 15 and 16 changing current mesh size from 30 to 40 mm opening according to Thompson and Bell model (from IRMA-CNR, 1999).

Fishing mortality (F)	Y/R(g) "30"	Y/R(g) "40"	Δ%	£/R "30"	£/R "40"	Δ%
0.5	5.8	5.9	+1.9	29	31	+5.5

In more recent literature, the exploitation rate (E) on the hake of GSA 15 and 16, estimated by demographic structure of the stock derived from trawl surveys (1994-1999), was about 0.56 in both sexes, suggesting a state of light overexploitation (SAMED, 2002).

According to Ben Mariem et al. (1995) and Gharbi et al. (2004), red mullet is fully exploited in the GSA 12 and 13, while the stock is overfished in the GSA 14. The scientists recommend to decrease the current fishing effort. On the basis of the yield per recruit analysis changing the mesh size from 38 to 50 mm an increase of yield should be obtained.

Levi et al. (2003) investigated the stock-recruitment relationship for Red mullet in the Strait of Sicily including environmental information in terms of sea surface temperature (SST) anomaly as a proxy for oceanographic processes affecting recruitment. The study showed that, for a given level of spawning stock, higher level of recruitment corresponded to SST warmer than average during the early life stages (Fig. 6.19.4.3).

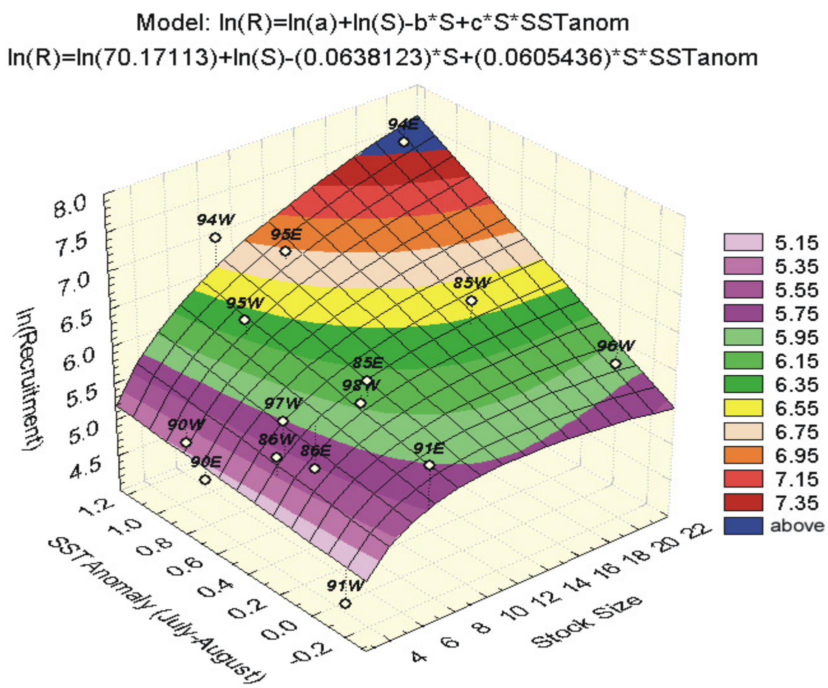


Fig. 6.19.4.3 - Stock-recruitment relationship including sea surface temperature anomalies of *M. barbatus* in the Strait of Sicily (GSA 16 and 15, excluding the MMFZ) (from Levi et al., 2003).

6.19.4.1 Method 1: Length cohort analysis

6.19.4.1.1 Justification

Five complete years (2006, 2007, 2008, 2009 and 2010) of length frequency distributions from GSA 16 commercial landings data (fished in GSA 15 as well as GSA 16) were available, so an approach under steady state (pseudocohort) assumptions was used. Cohort (VPA equation) and Y/R analysis as implemented in the package VIT4win were thus used (Lleonart and Salat, 2000). Data were derived from the DCF data call for GSA 16.

6.19.4.1.2 Input parameters

The used parameters were reported in table 6.19.4.1.2.1.

Table 6.19.4.1.2.1. *Mullus barbatus* growth parameters

Sex	Linf	k	t0	a	b
F	23.61	0.45	-0.80	0.0134	2.9419
M	20.16	0.57	-0.80	0.0176	2.8226

The maturity and natural mortality vector by size are reported in table XX. Terminal F was fixed as 0.5 and 0.6 for females and males respectively. Discard data was not included in the analysis.

Table 6.19.4.1.2.2. Maturity and natural mortality vector by size and sex

Age	Maturity		Natural mortality	
	F	M	F	M
0.5	0	0	0.56	0.73
1.5	1	1	0.34	0.41
2.5	1	1	0.29	0.35
3.5	1	1	0.27	0.32
4.5	1	1	0.27	0.31
5.5	1	1	0.26	0.3
6.5	1	1	0.26	0.29
7.5	1	1	0.25	0.29

Tab. 6.19.4.1.2.3 LFD of commercial *Mullus barbatus* landings (males) data from GSA 16 by fleet segment, used as input data for age slicing and subsequently VIT analysis.

FEMALES	Trawlers 12- 24m					Trawlers > 24m				
TL (cm)	2006	2007	2008	2009	2010	2006	2007	2008	2009	2010
10	0	21950	32747	79620	9769	71962	24445	5966	1281	0
11	73341	89675	136931	143983	39075	241602	376985	152354	10612	0
12	184470	181043	172645	296180	60929	155302	892669	643161	107211	0
13	373439	325228	252081	460328	147671	256052	580200	1034058	139698	3006
14	622821	550340	329227	755167	314110	657378	932302	1542678	160870	7647
15	800097	781254	603387	1030449	573011	1179859	1589075	1856986	250943	66292
16	767174	789684	722298	1196814	1000507	1035983	1583551	1221041	237170	166324
17	713698	754678	672504	1378089	1195672	866067	1238896	668492	121120	171370
18	709470	470496	570019	1173900	1092767	837793	560965	351724	30066	138145
19	545685	439610	391815	846310	826503	222484	374064	128776	10877	60697
20	282737	274003	275346	509094	562135	534828	60277	55419	2170	25282
21	206654	141389	125502	259338	270268	71962	24445	5966	1281	11913
22	5279587	4819350	4284502	8129272	0	241602	376985	152354	10612	0
total	5279587	4819350	4284502	8129272	6092418	6059310	8213428	7660655	1072016	650676

Tab. 6.19.4.1.2.4 LFD of commercial *Mullus barbatus* landings data from GSA 16 by fleet segment, used as input data for age slicing and subsequently VIT analysis.

MALES	Trawlers 12- 24m					Trawlers > 24m				
TL (cm)	2006	2007	2008	2009	2010	2006	2007	2008	2009	2010
10		77077	27190	103607	5375	229939	71051	59764	3290	0
11	246326	317378	185855	338306	24279	206814	831442	949656	32602	0
12	563238	693704	340439	640562	50115	364672	1851494	2483065	133996	0
13	541355	976438	837523	979729	108681	574918	1930867	2248945	353068	22518
14	470376	827749	990914	1192637	227453	1490228	2802320	2121474	449364	131132
15	492132	660035	746295	1093111	419193	1390963	2753708	1924233	172362	171097
16	480422	567854	699611	1154709	449571	582357	929144	766105	31773	129757
17	220040	235269	368133	800175	266980	144404	162348	122590	5056	41438
18	24759	36936	138709	288982	84681	56343	29063	18393	830	15262
19	93688	18447	66091	59933	27012	229939	71051	59764	3290	4249
total	3132336	4410888	4400758	6651750	1663340	5040636	11361437	10694225	1182341	515454

6.19.4.1.3 Results

Fishing mortality rates (F) for combined sexes by age class, fleet segment and year are shown in Fig. 6.19.4.1.3.1 below.

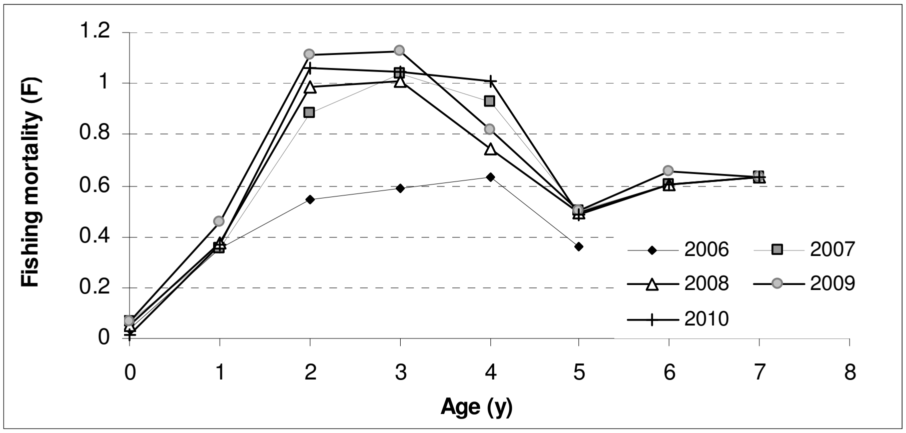


Fig. 6.19.4.1.3.1. Fishing mortalities rates (F) by age for combined sexes of *M. barbatus*.

Table 6.19.4.1.3.1 The main results of VIT analysis (GSA 16).

Variables	2006	2007	2008	2009	2010
Observed Yield (tons)	1124	1380	1177	800	757
Reconstructed Yield (tons)	1036	1343	1101	783	727
Estimated recruitment (ml)	39.3	57.7	48.0	31.6	40.2
Mean F	0.69	0.68	0.67	0.58	0.59

6.19.5 Short term prediction

No short term prediction were performed by STECF EWG 11-12.

6.19.6 Long term prediction

6.19.6.1 Justification

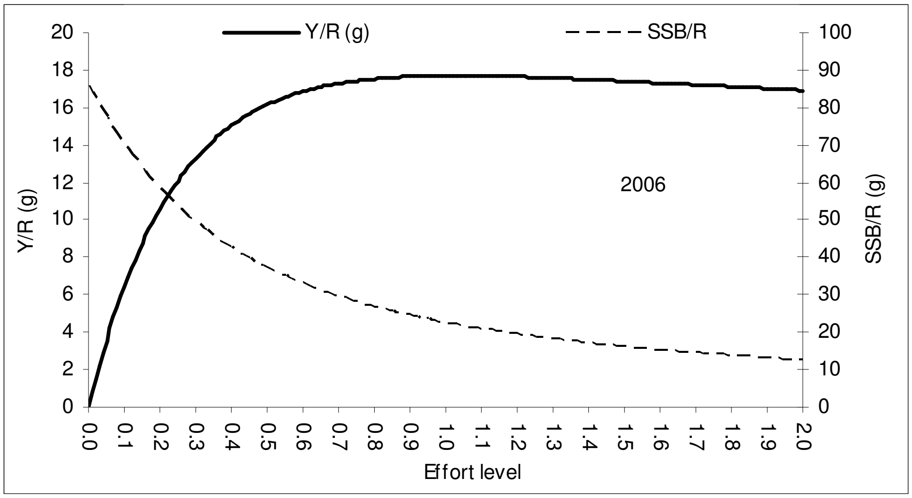
The YpR analysis provided by the VIT model has been appplied.

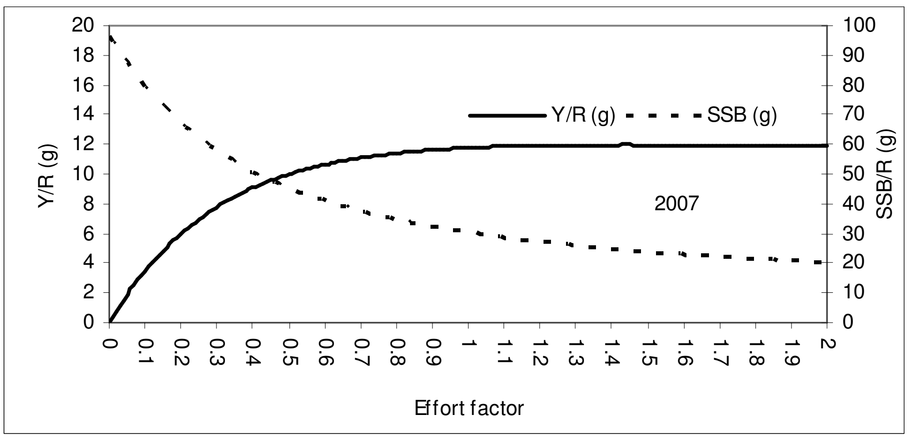
6.19.6.2 Input parameters

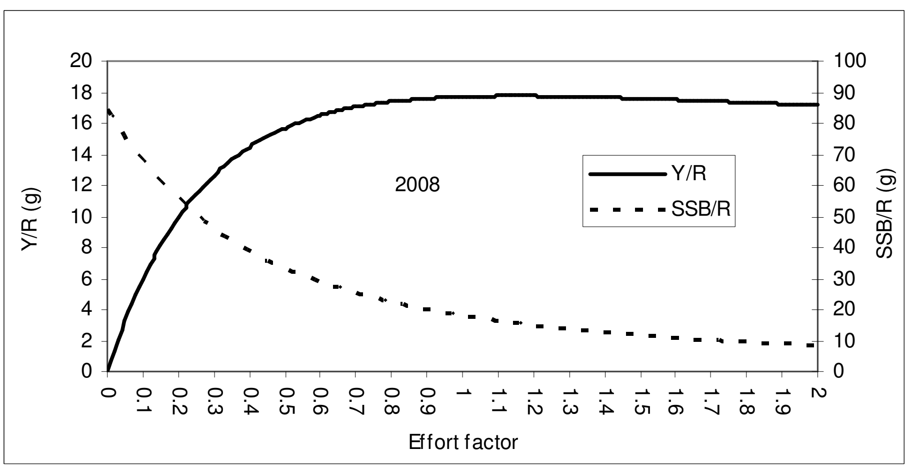
The input parameters are those used in the LCA (VIT) analysis described above.

6.19.6.3 Results

The YpR results of the VIT analysis, are listed in Table 6.19.6.3.1 and illustrated in Fig. 6.19.6.3.1.


Y/R (g)
SSB/R
2006
Y/R (g)
SSB/R (g)
Effort level


Y/R (g)
SSB (g)
2007
Y/R (g)
SSB/R (g)
Effort factor


Y/R
SSB/R
2008
Y/R (g)
SSB/R (g)
Effort factor

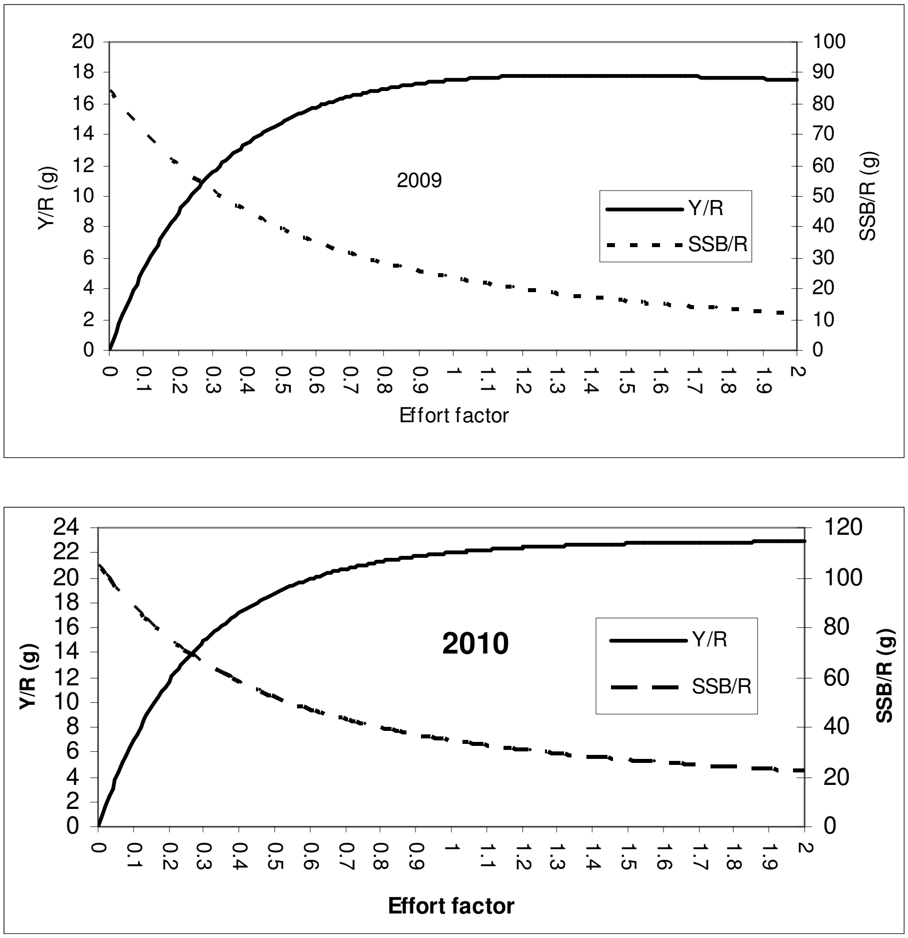


Fig. 6.19.6.3.1 Yield and Spawning Stock Biomass per recruit under varying current fishing mortality (Fc) according to the VIT package (combined sex).

Tab. 6.19.6.3.1. Estimation of yield (Y in g), biomass (B in g), spawning stock biomass (SSB in g) and spawning Potential Ratio (SPR in %) per recruit (R), varying current fishing mortality by a multiplicative factor (combined sex). Current fishing mortality was calculated taking into account ages 1-4. The factor corresponding to $F_{0.1}$ is marked in bold.

		Factor	Absolute F	Y/R	B/R	SSB	Y/R 12_24	Y/R >24
2006	Virgin	0.00	0.00	0.00	93.28	83.51	0.00	0.00
	$F_{0.1}$	0.53	**0.28**	16.13	43.56	33.98	6.07	10.06
	F_c	1.01	0.54	17.32	30.90	21.48	6.71	10.61
	F_{max}	1.03	0.55	17.32	30.44	21.03	6.72	10.60
2007	Virgin	0.00	0.00	0.00	94.65	82.99	0.00	0.00
	$F_{0.1}$	0.55	**0.44**	16.27	40.89	29.57	5.21	11.07
	F_c	1.01	0.81	17.41	29.44	18.34	5.57	11.84
	F_{max}	1.08	0.86	17.46	27.80	16.76	5.55	11.91
2008	Virgin	0.00	0.00	0.00	94.65	82.99	0.00	0.00
	$F_{0.1}$	0.58	**0.45**	16.14	39.55	28.20	6.05	10.09
	F_c	1.01	0.79	17.26	28.58	17.41	5.89	11.37
	F_{max}	1.13	0.88	17.31	26.42	15.32	5.76	11.54
2009	Virgin	0.00	0.00	0.00	94.65	82.99	0.00	0.00
	$F_{0.1}$	0.67	**0.59**	16.17	41.83	30.54	15.29	0.88
	F_c	1.01	0.89	17.09	33.80	22.65	16.03	1.07
	F_{max}	1.32	1.16	17.38	28.20	17.22	16.21	1.17
2010	Virgin	0.00	0.00	0.00	97.07	87.63	0.00	0.00
	$F_{0.1}$	0.60	**0.51**	16.02	45.16	35.75	12.98	3.03
	F_c	1.01	0.87	17.26	34.39	25.00	13.70	3.56
	F_{max}	1.36	1.17	17.40	30.52	21.16	13.64	3.76

6.19.7 Data quality and availability

STECF EWG 11-12 noted a lack of discards data for *Mullus barbatus* in GSA 15 and GSA 16. Both data on total estimated discards in tones and discards at length data were missing. The relevant data sheet to be verified are (1) Italian as well as Maltese catch data, GSAs 15 and 16, bottom otter trawl gear, *Mullus barbatus*, discards and (2) discards at length data, bottom otter trawl gear, GSAs 15 and 16, *Mullus barbatus*.

6.19.8 Scientific advice

6.19.8.1 Short term considerations

6.19.8.1.1 State of the spawning stock size

According to VIT analysis, absolute estimations of SSB (combined sex) in the 2006-2010 was 1070 t in 2006, 1307 t in 2007, 1046 t in 2008, 905t in 2009 and 1072 t in 2010. In the asence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

6.19.8.1.2 State of recruitment

The estimates of absolute recruitment in millions of individuals (age class 0) from VIT analysis in 2006-2010 were 39.3 in 2006, 57.7 in 2007, 48.0 in 2008, 31.6 in 2009, and 40.2 in 2010.

6.19.8.1.3 State of exploitation

The STECF EWG 11-12 propose F0.1=0.45 (Fmsy proxy) as limit reference point consistent with high long term yields and low risk of fisheries collapse. The VIT assessments 2008-2010 indicate current fishing mortality in the range F=0.8. The STECF EWG 11-12 classifies the status of the stock of red mullet in the Northern sector of the Strait of Sicily as being subject ot overfishing. Thus EWG reccomends that fishing effort is reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

6.19.8.2 Medium term considerations

Considering the Sicilian fleet operating in GSAs 15-16, for which both commercial data were available at STECF EWG 11-12, a reduction of about 40% of the fishing mortality needs to reach F_{01}=0.45 (median value of the 2006-2010 assessments). However stock show signs of increasing trend in SSB and recruitment indices from trawl surveys. This could be correlated with the reduction of illegal trawling in the coastal areas within the 50 m depth where the recruitment of the species occur in late summer-early autumn, to the reduction of fishing effort since 2008 and to the positive effect of warming of the surface seawater on the recruitment success (Levi et., 2003).

The working group was informed that the Italian government has adopted a management plan in which a reduction of trawler capacity of 25% is planned within 2013. EWG 11-12 recommends to continuously reduce current F through consistent effort reductions, and an improvement in current exploitation patterns.

6.20 Stock assessment of giant red shrimp in GSAs 15 and 16

6.20.1 Stock identification and biological features

6.20.1.1 Stock Identification

The EWG 11-12 defines the stock unit of giant red shrimp (*A. foliacea*) as being confined in GSAs 15 and 16.

6.20.1.2 Growth and natural mortality

Considering the northern sector of the Strait of Sicily (GSA 15 and 16) the observed maximum length was 70 mm. After age slicing with the parameters estimated by CNR-IAMC (2009; Table 6.20.1.2.1 below), the maximum estimated age in years in the exploited standing stock resulted to be 6 years. The growth parameters estimated in the past for the Strait of Sicily are reported in Table x for comparative purposes.

During the SGMED 02 09 workshop new parameters were estimated in order to allow a better performance of VIT approach. This new parameters, with an higher linf and lower k than the parameters given by the data call but showing a very similar growth performance (see Φ' column in table…), were obtained by the Powel-Wetherall method (linf) and the ELEFAN "K scan" routine (K). Data used were the length frequency distributions collected in trawl surveys from 1994 to 2008. Parameters were estimated by the package FISAT II (Gayanilo et al., 2005).

Table 6.20.1.2.1 Von Bertalanffy growth function and length-weight relationship parameters in the Strait of Sicily (GSA 15 and 16). L_{inf} as CL in mm

Reference	Sex	Linf	K	t_0	Φ'	a	b
Ragonese *et al.* (1994)	Females	65.5	0.67	0.28	3.459	/	/
	Males	41.5	0.96	0.28	3.218	/	/
Cau et al. (2002)	Females	65.5	0.67	/	3.459	/	/
AAVV (2008); Red's Project	Females	62.24	0.65	0.05	3.401	0.002	2.507
	Males	40.31	0.79	-0.44	3.108	0.002	2.618
Ragonese *et al.* (2004)	Females	65.8	0.52	-0.23	3.352	0.00176-0.00210	2.51-2.56
	Males	/	/	/	/	0.00116-0.00135	2.65-2.69
CNR-IAMC (2009)	Females	61,66	0,78	-0,22	3.472	0.0016	2.5884
	Males	41.95	0,70	-0,18	3.091	0.0010	2.7456
SGMED 02 09	Females	68.9	0.61	-0.2	3.462	0.0013	2.636

6.20.1.3 Maturity

Although spawning of *A. foliacea* occurs from spring till autum in the Strait of Sicily, maturity peaks in summer (Ragonese and Bianchini, 1995). According to Ragonese *et al*. (2004) the length at 50% of maturity was 42 mm CL in females and 30-33 mm CL in males. The most recent assessment of maturity ogive was given by CNR_IAMC (2009), being L50%=37.17 (es=0.108) mm CL and slope g=0.541 (es=0.028) in females and L50%=27.41 (es=0.0.037) mm CL and slope g=0.988 (es=0.031) in males.

6.20.2 Fisheries

6.20.2.1 General description of fisheries

The giant red shrimps is a relevant target species of the Sicilian and Maltese trawlers and is caught on the slope ground during all year round, but landing peaks are observed in summer. *A.foliacea* is fished exclusively by otter trawl, mainly in the central–eastern side of the Strait of Sicily, whereas in the western side it is substituted by the violet shrimp, *Aristeus antennatus* **.**

Due to reduction of catch rate since 2004 some distant trawlers based in Mazara del Vallo, which is the main fleet in the area, recently moved to the eastern Mediterranean (Aegean and Levant Sea) to fish red shrimps Garofalo et al., 2007).

A rough delimitation of the most important fishing grounds of red shrimps in the Strait of Sicily is reported in Ragonese (1995) (Fig 6.20.2.1.1).

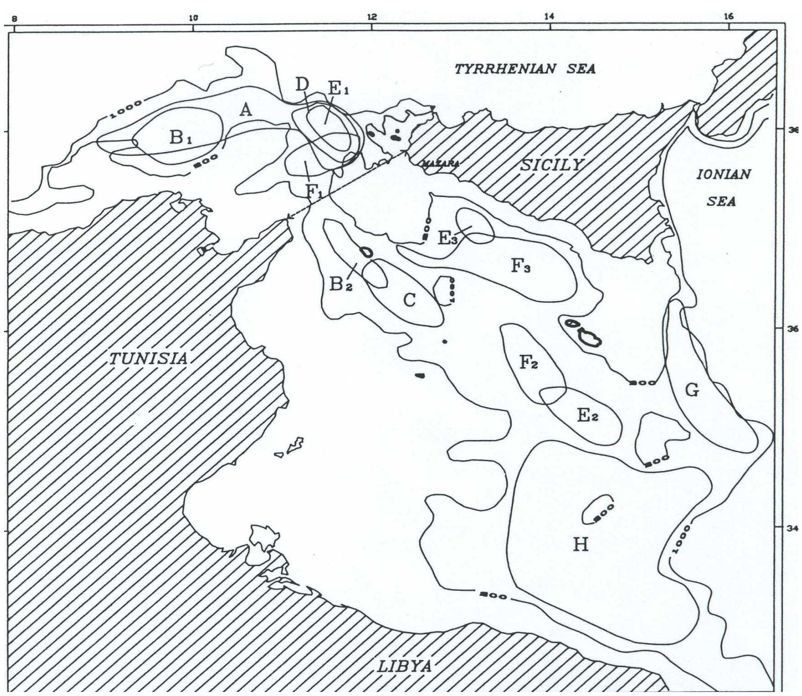


Fig. 6.20.2.1.1 Main fishing grounds of giant red shrimps in the Strait of Sicily according to Ragonese (1995).

In Maltese waters, trawlers targeting the giant red shrimp *A. foliacea* within the 25nm fisheries management zone trawl either to the north / north-west of the Island of Gozo, or to the west / south-west of Malta, at depths of about 600m. Detailed maps of the trawling grounds for Maltese Fisheries Management Zone (FMZ), including a wide part of GSA 15 are available (Camilleri *et al*., 2008).

Giant red shrimps are frequently caught together with Norway lobster (*Nephrops norvegicus*), large sized deep water pink shrimp (*Parapenaeus longirostris*), the more rare violet shrimp (*Aristeus antennatus*) as well as large hake (*Merluccius merluccius*).

In terms of fishing gear, the Italian and Maltese trawlers operating in the Strait of Sicily use the same typology of trawl net called "Italian trawl net". Although some differences in material between the net used in shallow waters ("banco" net, mainly targeted to shelf fish and cephalopods) and that employed in deeper ones ("fondale " net, mainly targeted to deep water crustaceans) exist, the Italian trawl net is characterized by a low vertical opening (up to 1.5 m) with dimensions changing with engine power (Fiorentino *et al*., 2003).

6.20.2.2 Management regulations applicable in 2010 and 2011

At present there are no formal management objectives for giant red shrimp fisheries in the Strait of Sicily. As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area/season closures). No minimum landing sizes is established for this species (EC 1967/06).

The adoption of the trawling ban of 30-45 days per year by the Sicilian Government since late eighties have should contributed to reduce the fishing effort on demersal resources off the Sicilian coast. However this measure for many years had low efficacy for this species because the period of stopping trawling was not chosen to reduce fishing mortality on juveniles of giant red shrimps (in late spring-early summer).

In order to limit the over-capacity of fishing fleet, Maltese fishing licenses have been fixed at a total of 16 trawlers since 2000. Eight new licences were however issued in 2008, a move made possible under EU law by the reduction of the capacities of other Maltese fishing fleets.

In terms of technical measures, the new regulation EC 1967 of 21 December 2006 fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels (Italian and Maltese trawlers). Mesh size had to be modified to square 40 mm or diamond 50 mm in July 2008, however derogations are possible up to 2010. Moreover, the Maltese Islands are surrounded by a 25 nautical miles (nm) fisheries management zone, where fishing effort and capacity are being managed by limiting vessel sizes, as well as total vessel engine powers (EC 813/04; EC 1967/06). Trawling is allowed within this designated conservation area, however only by vessels not exceeding an overall length of 24m and only within designated areas. Such vessels fishing in the management zone hold a special fishing permit in accordance with Article 7 of Regulation (EC) No 1627/94, and are included in a list containing their external marking and vessel's Community fleet register number (CFR) to be provided to the Commission annually by the Member States concerned. Moreover, the overall capacity of the trawlers allowed to fish in the 25nm zone can not exceed 4 800 kW, and the total fishing effort of all vessels is not allowed to exceed an overall engine power and tonnage of 83 000 kW and 4 035 GT respectively. The fishing capacity of any single vessel with a license to operate at less than 200m depth can not exceed 185 kW. In addition, the use of all trawl nets within 1.5nm of the coast is prohibited according to EC regulation 1967 / 2006, although again a transitional derogation is at present in place until 2010.

6.20.2.3 Catches

6.20.2.3.1 Landings

Yield of both the Italian and Maltese trawlers peaked in 2009 with a total of 1951 t, compared to an average of 1400 t in 2005-2008. At 1340 t landings in 2010 were slightly below the 2005-2008 average.

Table 6.20.2.3.1.1 Landings (t) by year and major gear types, 2005-2010 as reported through the DCF; OTB = bottom otter trawls.

Area	Country	Fleet	2005	2006	2007	2008	2009	2010
15	Malta	OTB	17.66	29.7	34.3	27.1	41.5	27.4
16	Italy	OTB	1270.3	1424.2	1540.5	1260.1	1909.8	1313.9
15 & 16	Italy&Malta	OTB	1287.96	1453.9	1574.8	1287.2	1951.3	1341.3

The most recent Italian and Maltese data were collected within the framework of the DCF. Available information is considered feasible by the experts attending the working group, with the exception of 2004 yield data that could underestimated by mistake of species identification (giant red shrimps erroneously classified as *Aristeus antennatus*). As a consequence, 2004 data was not included in the present analysis.

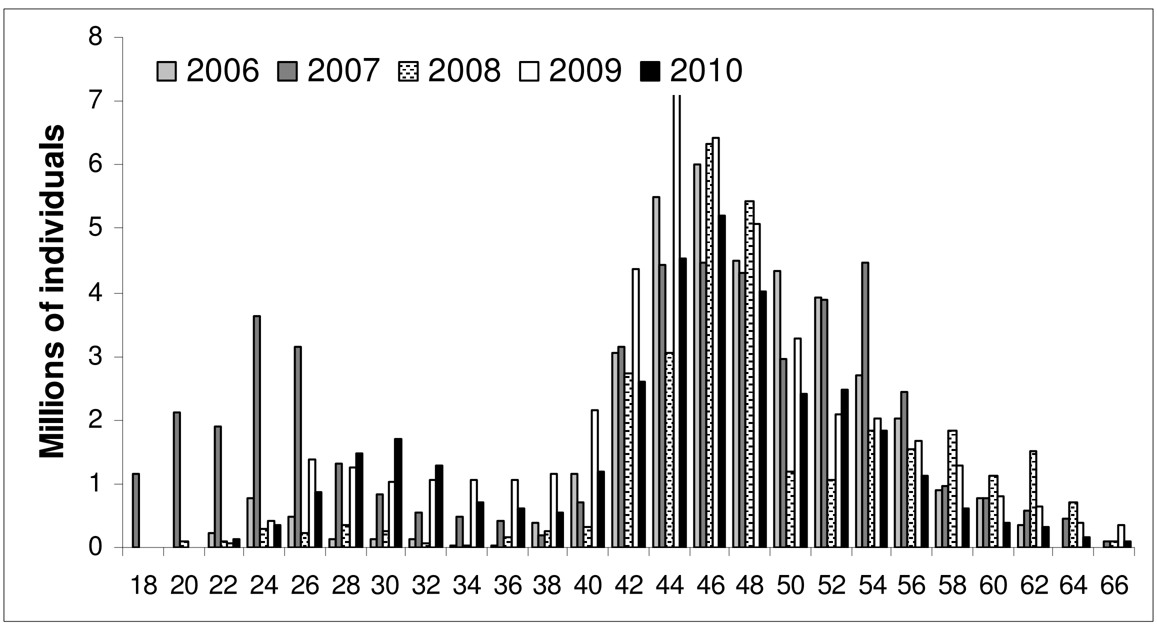


Figure 6.20.2.3.1.1 Yearly length structure of giant red shrimp landings in absolute numbers of Sicilian trawlers fishing in the Strait of Sicily (GSA 12, 13, 14, 15 and 16).

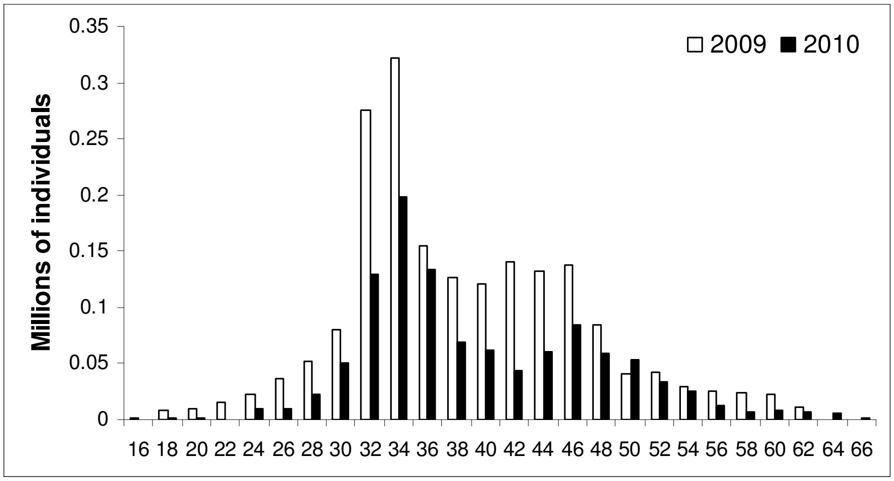


Figure 6.20.2.3.1.2. Yearly length structure of giant red shrimp landings in absolute numbers of Maltese trawlers fishing in the Strait of Sicily (GSA 15).

6.20.2.3.2 Discards

According to information available to the WG no catches of red shrimp were discarded by Italian trawlers.

An assessment of the discards made by the Maltese fishing industry was carried out in 2005. Results showed that there is no discard practice amongst boats smaller than 10 m and that for larger boats the discard rate is negligible (average 4.7%). More detailed information on volume and species composition of the discards of vessels larger than 10 m by gear type and fleet segment was compiled under the new Data Collection Framework in 2009 and 2010. Based on this analysis, Maltese trawlers discarded 1.3 tonnes of *A. foliacea* in 2009 and 0.2 tonnes in 2010. Besides the general decrease in landings in 2010 compared to 2009, the drop in discards is likely to be due to the introduction of new trawl mesh sizes.

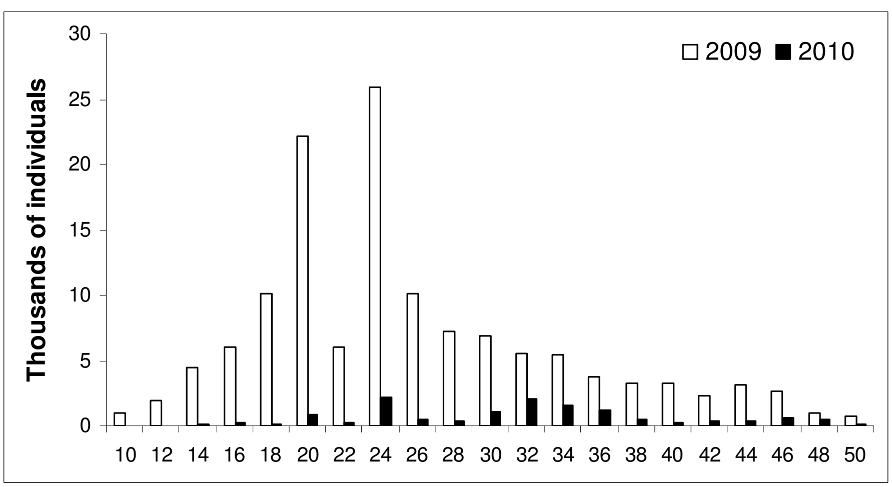


Figure 6.20.2.3.2.1 Yearly length structure of giant red shrimp discards in absolute numbers of Maltese trawlers fishing in the Strait of Sicily (GSA 15).

6.20.2.4 Fishing effort

The trends in fishing effort by year and major gear type is shown in Fig. 6.20.2.4.1 in terms of kw*day for the otter trawls. It worth noting that Italian effort is 98-99% of the total one.

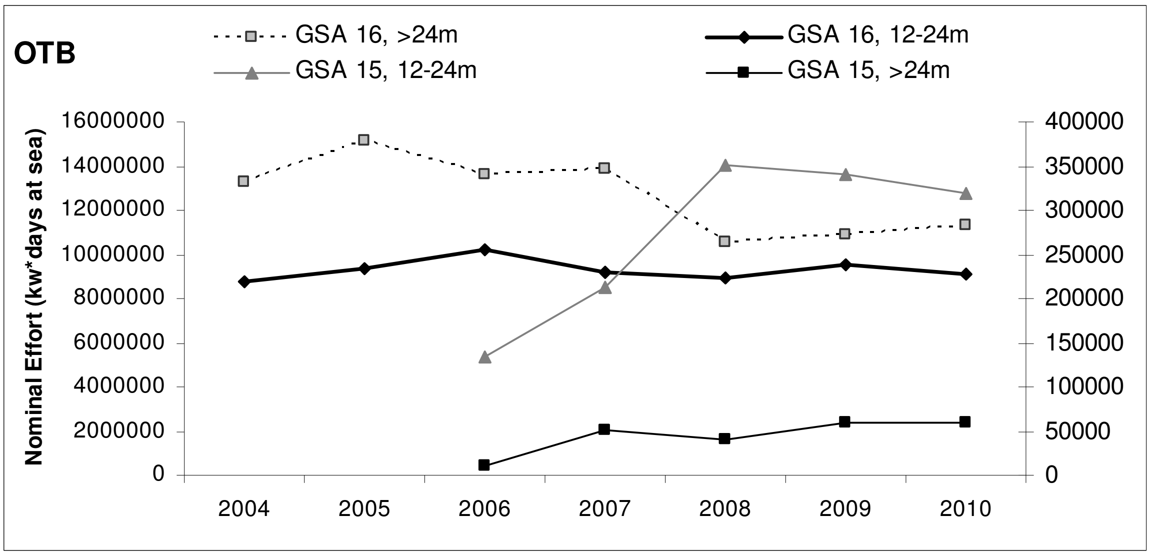


Fig. 6.20.2.4.1 Nominal effort (kW*days at sea) trends of trawlers (OTB) by segments in GSA 15 (left) & 16 (right), 2004-2010

6.20.3 Scientific surveys

6.20.3.1 Medits

6.20.3.1.1 Methods

Based on the DCR data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In GSA 15 and 16 the following number of hauls were reported per depth stratum (s. Tab. 6.20.3.1.1.1-2).

Tab. 6.20.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 1994-2010.

Depth (m)	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
10-50	4	4	4	4	4	4	4	4	7
50-100	8	8	8	8	8	8	7	8	11
100-200	4	4	4	4	5	5	6	5	10
200-500	10	11	11	12	11	11	11	11	19
500-800	10	14	14	13	14	14	14	14	19
Depth (m)	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	
10-50	7	7	10	10	11	11	11	11	
50-100	12	12	20	22	23	23	23	23	
100-200	8	9	18	19	21	21	21	21	
200-500	18	19	28	31	27	27	27	27	
500-800	20	19	32	33	38	38	38	38	

Tab. 6.20.3.1.1.2. Number of hauls per year and depth stratum in GSA 15, 2002-2010.

Depth (m)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
10-50	1	1	2	1	1	0	0	0	0
50-100	5	5	4	5	5	12	6	6	6
100-200	13	13	13	13	13	12	13	14	14
200-500	10	10	10	9	10	4	9	10	10
500-800	16	16	15	17	16	17	17	15	15

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.20.3.1.2 Geographical distribution patterns

No analyses were conducted during STECF EWG 11-12. However some information on the ready to spawn female aggregate reported by Ragonese and Bianchini (1995) are shown in figure…..

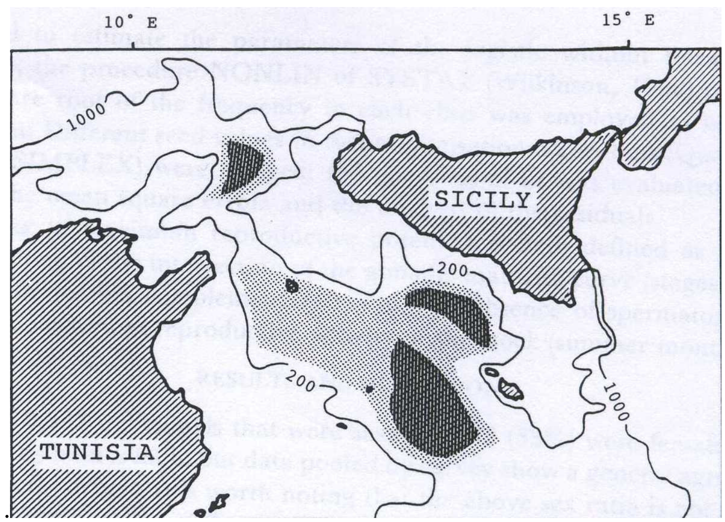


Fig. 6.20.3.1.2.1 Spawning areas of female according to Ragonese and Bianchini (1995).

6.20.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the giant red shrimp in GSAs 15 and 16 was derived from the international surveys MEDITS. Figures x and x indicate the stock to decline very slightly in 2004-2007, before increasing in 2008 and peaking in 2009. In 2010 the stock returned to abundance / biomass levels recorded in 2005-2007.

Erroneously high biomass indices were recorded for giant red shrimp in GSA 15 in 2006: 46.9 kg/h compared to an average of 0.65 kg/h in 2007-2010. This is almost certainly due to an error in raising procedures.

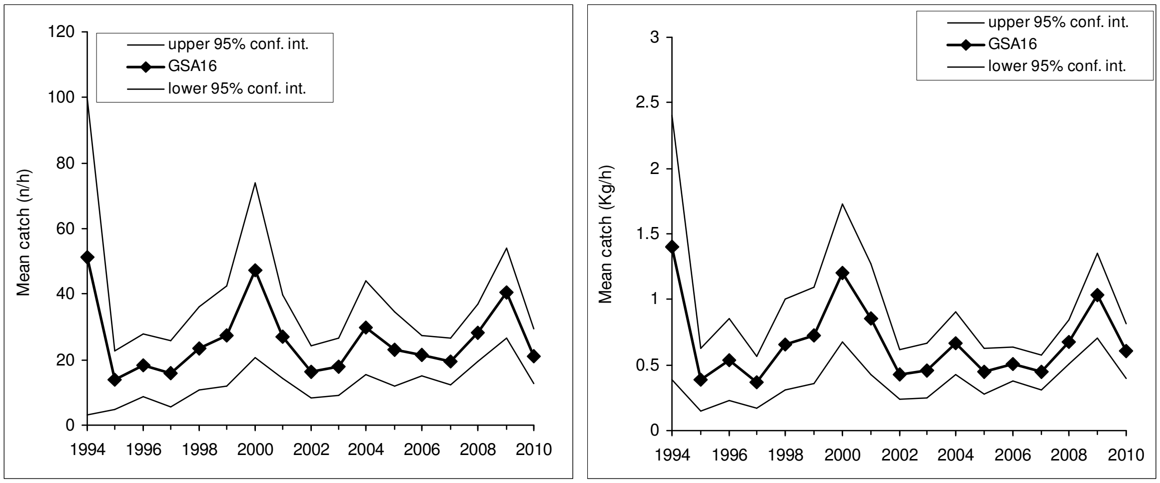


Fig. 6.20.3.1.3.1 Abundance and biomass indices of giant red shrimp in GSA 16.

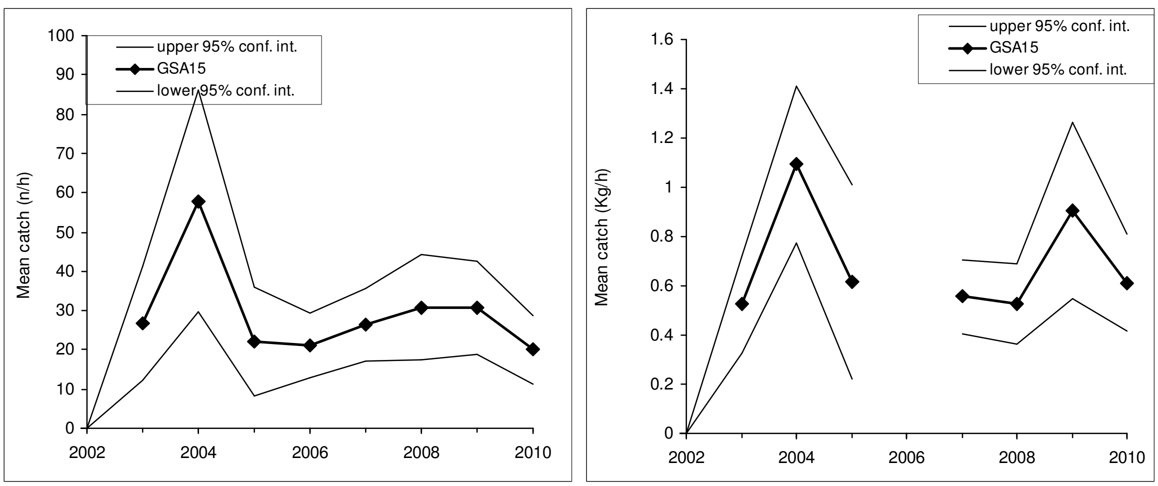


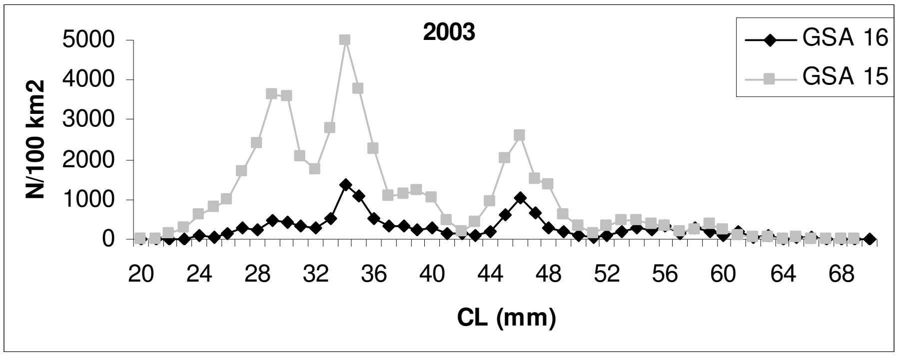
Fig. Fig. 6.20.3.1.3.1 Abundance and biomass indices of red mullet in GSA 15. Erroneously high biomass indices were provided to STECF EWG 11-12 for 2006.

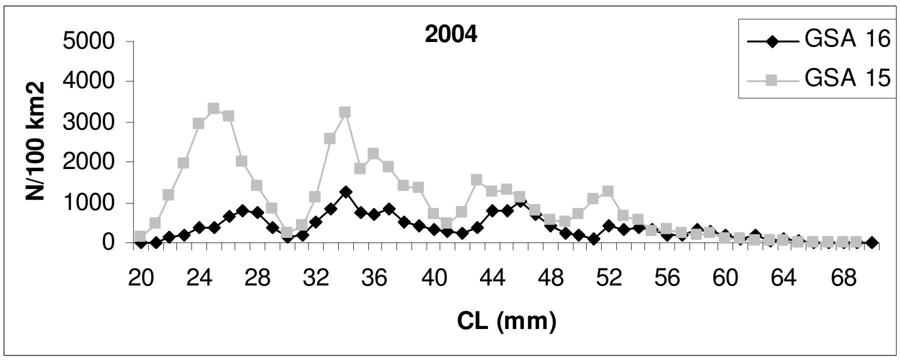
6.20.3.1.4 Trends in abundance by length or age

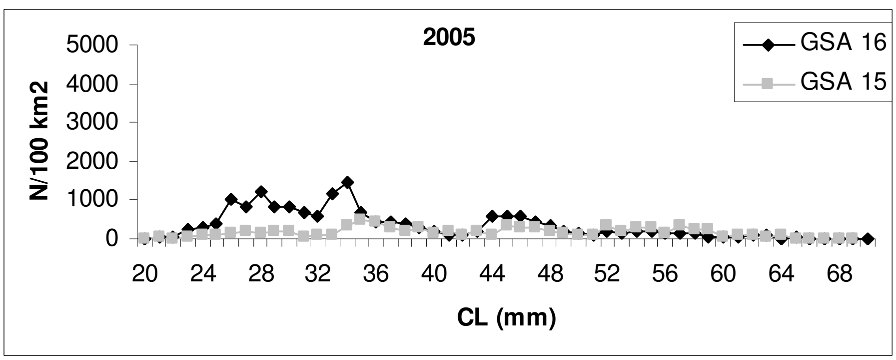
The following Fig. 6.20.3.1.4.1 displays the stratified abundance indices (strata d and e) of giant red shrimp in GSA 15 and GSA 16 in 2003-2010.

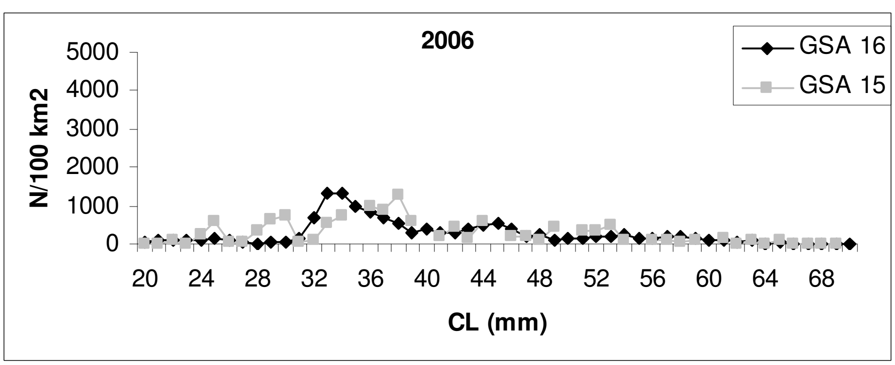
Higher number of juveniles were recorded in GSA 15 in 2003/2004 as well as in 2007/2008. Moreover, the number of giant red shrimp encountered per 100km2 was 34% higher in GSA 15 compared to GSA 16 in 2009, and 27% higher in 2010.

Since the horizontal opening of the GOA 73 reported in the data base was higher in GSA 16 than GSA 15 despite the fact that the same vessel (Sant Anna), the same captain and the same haul protocol are being used, further checks of the swept area should be performed.


2003
GSA 16
GSA 15
N/100 km2
5000
4000
3000
2000
1000
0
20
24
28
32
36
40
44
48
52
56
60
64
68
CL (mm)


2004
GSA 16
GSA 15
N/100 km2
5000
4000
3000
2000
1000
0
20
24
28
32
36
40
44
48
52
56
60
64
68
CL (mm)


2005
GSA 16
GSA 15
N/100 km2
5000
4000
3000
2000
1000
0
20
24
28
32
36
40
44
48
52
56
60
64
68
CL (mm)


2006
GSA 16
GSA 15
N/100 km2
5000
4000
3000
2000
1000
0
20
24
28
32
36
40
44
48
52
56
60
64
68
CL (mm)

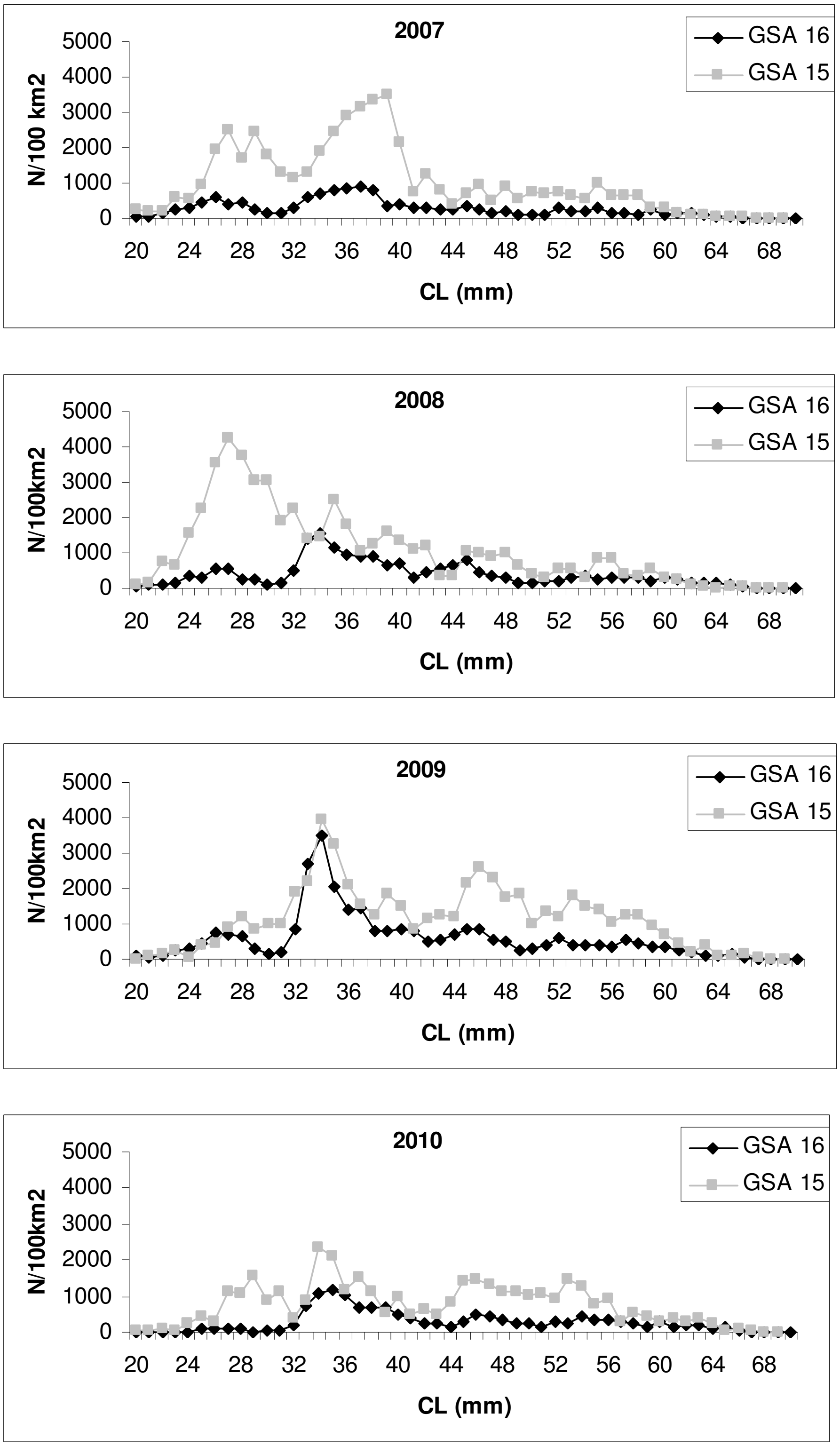


Fig. 6.20.3.1.4.1 Stratified abundance indices by size class in GSA 15 and 16, 2003-2010

The Figure 6.20.3.1.4.2 displays the stratified abundance indices of giant red shrimp in GSA 16 in 1994-2002.

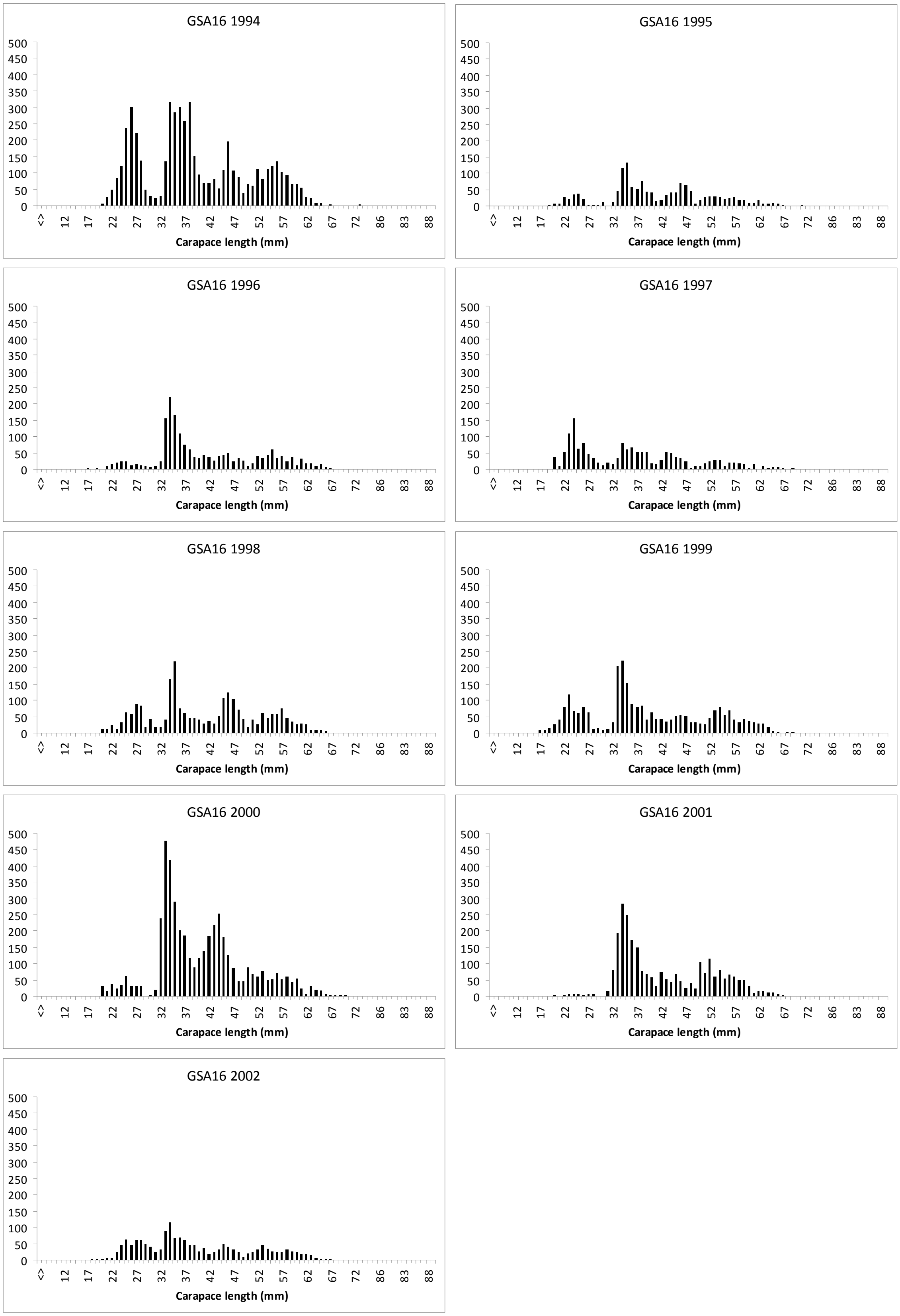


Fig. 6.20.3.1.4.2 Stratified abundance indices by size class in GSA 16, 1994-2002

6.20.3.1.5 *Trends in growth*

No analyses were conducted during STECF EWG 11-12.

6.20.3.1.6 *Trends in maturity*

No analyses were conducted during STECF EWG 11-12.

6.20.4 *Assessment of historic stock parameters*

6.20.4.1 Method 1: SURBA

6.20.4.1.1 *Justification*

The availability of time series (2002-2010 for GSA 15 and 1994-2010 for GSA 16) of length frequency distribution (LFD) from trawl surveys data allows to reconstruct the evolution of main stock parameters (recruitment and spawning stock biomass indices and fishing mortality rates) of giant red shrimps in the GSA 15 and 16 by using the SURBA software package. Since females reach the largest size and they are more sensitive to fishery pressure, analysis were carried out only on females fraction, which represent about the 60 % of the commercial catch (mean of period 2006-2009).

Firstly the LFD by sex from the MEDITS trawl surveys was corrected by including the data for the individuals with unidentified sexes. This was based on the sex ratio per size class. The corrected LFDs by sex for each GSA were then converted in numbers by age group using the subroutine "age slicing" as implemented in the software package LFDA (Kirkwood *et al*., 2001). Secondly we estimated the mean weight and maturity at age using VBGF and a vectorial natural mortality at age (PRODBIOM excel sheet as implemented by Abella in SGMED 01 09) for the SURBA software to run the analysis. Then the numbers at age were used to estimate time series of fishing mortality rates, and recruitment and SSB indices. Since the time series for GSA 15 is too short (from 2002 to 2010), SURBA analysis was done only considering the GSA 16 information (1994-2010).

6.20.4.1.2 *Input parameters*

The input parameters are reported in table 6.20.4.2.2.1 .

Tab. 6.20.4.2.2.1 Female Biological parameters used for Surba analyses for giant red shrimp (females) in the Strait of Sicily (GSA 16).

growth			maturity		weight	
Linf	K	t0	Lm	g	a	b
68.9	0.61	-0.2	37.17	0.541	0.0016	2.5884

A declining value of M with age instead of a constant value was used based on the outcome of discussions held at SGMED_09_01, where the experts concluded such an approach is necessary considering the early age of first capture and the massive catch of juveniles characterised by higher M rates in most of the Mediterranean fisheries: natural mortality rates by age were calculated according to the ProdBiom model developed by Abella, Caddy and Serena (1997), based on Caddy (1991).

The value by age used in the analysis are given in Tab. 6.20.4.2.2.2 The age slicing produced only 6 age group (up age 5+).

Tab. 7.10.4.2.2.2 Values by age used for Surba analyses for female giant red shrimp (females) in GSA 16.

Age	0	1	2	3	4	5+
Natural mortality at age	0.62	0.30	0.23	0.19	0.17	0.16
Maturità at age	0.03	0.80	1.0	1.0	1.0	1.0
Weight at age	5.79	26.70	50.28	67.62	78.22	84.23
Catchability coefficient	0.4	0.8	1.0	1.0	1.0	1.0

6.20.4.1.3 Results

State of female adult / juvenile abundance:

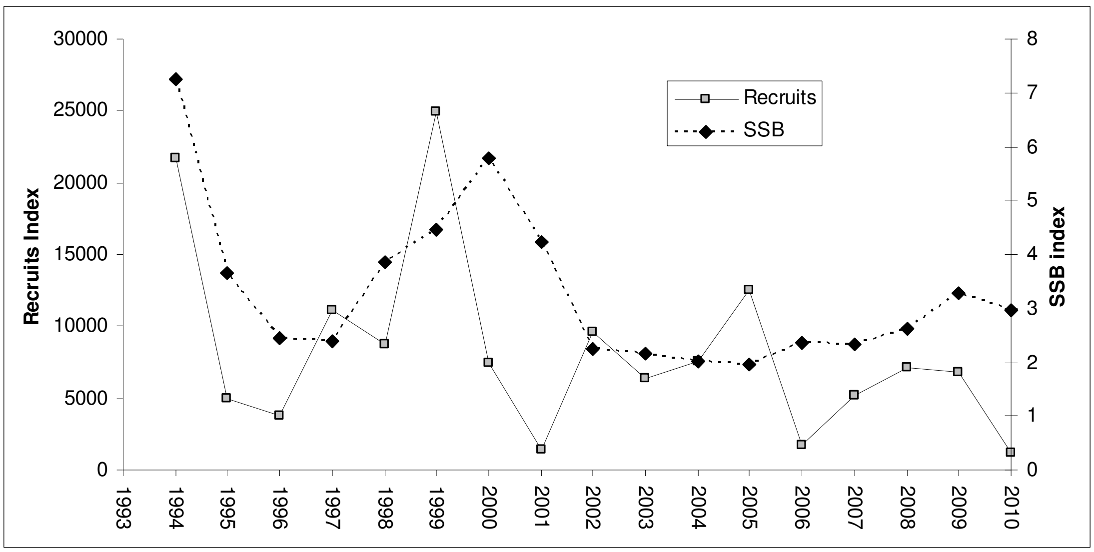


Fig. 6.20.4.1.3.1 Female SSB in kg/km^2 and recruits n/km^2 (MEDITS survey), as median of SURBA bootstrapped values, in GSA 16.

From 1994 to 2001 recruitment as well as spawning stock biomass indices fluctuate highly, with the lowest number of recruits recorded in 2001. From 2002 to 2010 spawning stock biomass remained stable on low level, whilst recruitment abundance recruits abundance reached the low levels recorded in 2001 in both 2006 and in 2010.

The values of F (age 1-3) in GSA 16 from 2000 to 2007 remains high, with values around 0.9. To avoid bias in F estimation due to unavailability of three cohorts for which F were averaged, the F estimate was only considered reliable up to 2008.

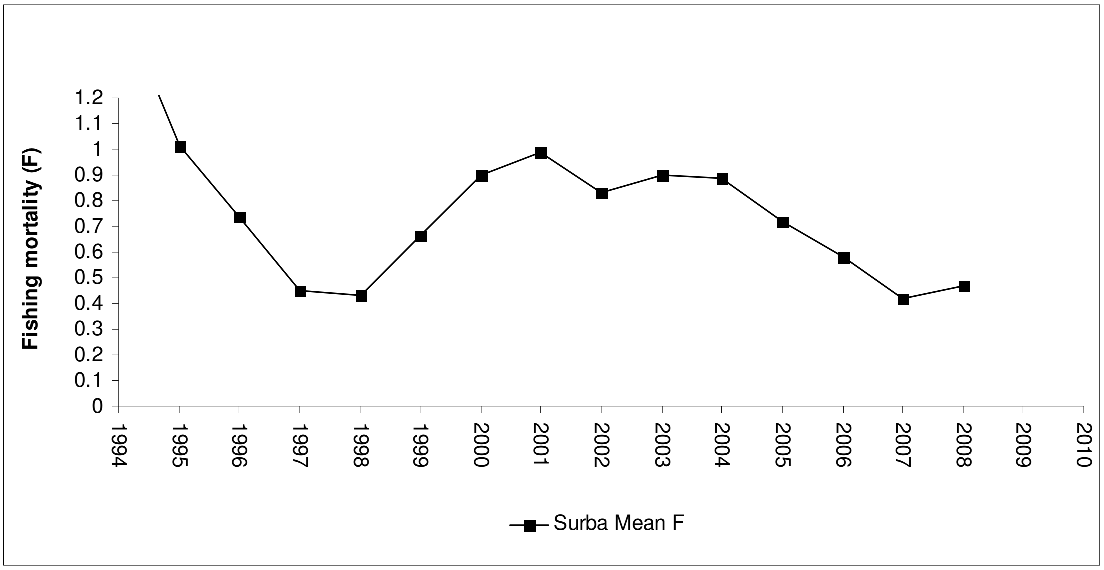


Fig. Development of female fishing mortality ($F_{1\text{-}3}$) (MEDITS survey), as median of SURBA bootstrapped values, in GSA 16. Due to the limit of the SURBA method, estimates were given up to 2008.

6.20.4.2 Method 3: VIT

6.20.4.2.1 Justification

According to the SGMED 03 2008 suggestions an approach under steady state (pseudocohort) was used keeping separate the available years (2006-2010). Cohort (VPA equation) and yield per recruit analysis as implemented in the package VIT4 win were used (Lleonart and Salat, 2000). Data were derived from DCF data call for GSA 15 and 16.

6.20.4.2.2 Input parameters

The parameters used in the analysis are reported in table 6.20.4.2.2.1-2. No discard data were included since discard information was lacking for GSA 16. Analyses were carried out on the landings of Italian and Maltese trawlers operating in GSA 15 and 16. Since females reach larger size than males and amount to more than 60% of landing in weight (mean 2006-2010), females catch structure and parameters were used to assess stock exploitation of the total catches (both sex combined). This choice was also due to the fact that available stock VBGF parameters for males are not considered accurate (Ragonese at al., 2004).

Natural mortality and maturity by size are shown in figure 6.20.3.1.4.1.

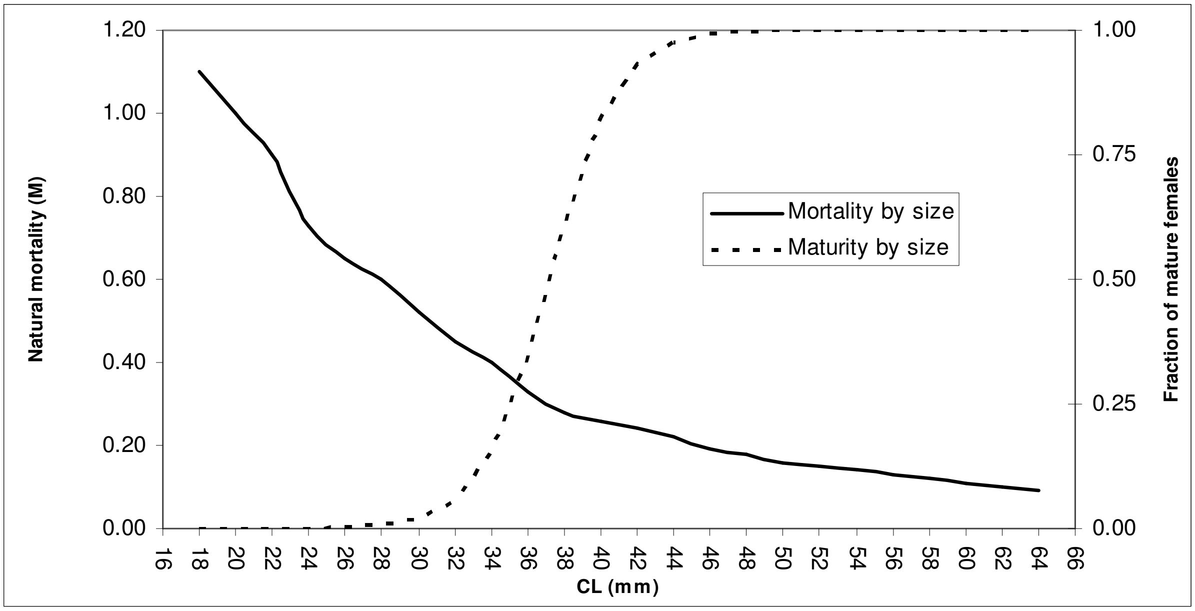


Fig. 6.20.3.1.4.1 Female natural mortality (M) and maturity by length (CL) of giant red shrimp in the Strait of Sicily.

Table 6.20.3.1.4.1 Absolute number by length class (CL in mm) of females landed by year in the Strait of Sicily.

CL (mm)	2006	2007	2008	2009	2010
18	0	1147718	0	0	0
20	0	2127058	100306.2	0	0
22	237775.4	1890491	100306.2	51574	127414
24	772770.1	3623935	305042.5	412592	359904
26	475550.8	3149727	215544.7	1388185	866497
28	118887.7	1318576	341744.8	1267871	1473459
30	127265.8	842285.6	256317.1	1018950	1697170
32	127265.8	532422.2	58257.5	1055220	1291634
34	31831.27	470658.9	41612.88	1052649	696676
36	31831.27	408893.2	145912.7	1047737	626244
38	379236	181203.5	243618.9	1156809	536708
40	1142386	711989.2	327243.4	2157004	1201883
42	3044008	3151277	2740826	4377946	2599471
44	5496558	4435267	3064312	7133900	4544630
46	6012676	4454301	6327786	6431671	5201250
48	4499250	4313914	5444355	5080945	4004438
50	4328759	2964016	1190867	3283812	2423721
52	3934095	3878326	1051074	2078437	2458156
54	2702964	4481193	1845097	2012452	1844386
56	2027310	2456743	1555172	1680363	1137034
58	904015.7	962710.1	1846294	1274067	607871
60	760427.9	761040.8	1128505	809822	379241
62	359591.3	574764.1	1515911	630901	334919
64	0	446162	712458	389640	164775
66	0	110052	101302.7	357679	81275
Total	37514455	49394723	30659868	46150230	34658755

6.20.4.2.3 Results

Fishing mortality rates (F) by size of female giant red shrimps caught by trawlers in GSA 15 and 16 are shown in Fig. 6.20.4.2.3.1.

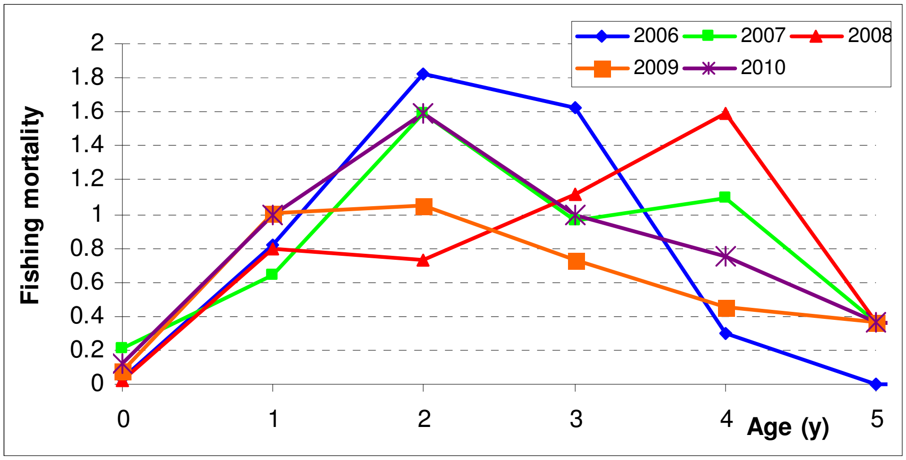


Fig. 6.20.4.2.3.1 Fishing mortality by age of female giant red shrimp in the Strait of Sicily.

The reconstructed yields obtained by the VIT package are virtually equal to the observed ones. Absolute recruitment estimation and other main results of VIT, including the current mortality rates, are listed in table 6.20.4.2.3.1.

Table 6.20.4.2.3.1 The main results of VIT analysis for the female fraction of the population.

Year	2006	2007	2008	2009	2010	Median
Official total yield (t)	1450	1574	1287	1659	1684	1574
Estimated SSB (t)	1070	1370	1300	1580	1260	1370
Recruitment (ml)	98.1	114.0	83.0	118.0	122.6	114
Mean Z over all age	1.22	1.00	0.96	0.83	0.99	0.99
Mean F over all age	0.92	0.74	0.70	0.57	0.73	0.73
Mean F (1-4 age groups)	1.14	1.07	1.05	0.81	1.09	1.07

6.20.5 Short term prediction

Will be accomplished during the follow up meeting during 16-20 January 2012.

6.20.6 Long term prediction

6.20.6.1 Method 1: Y, B and SSB per recruit according to the VIT package

6.20.6.1.1 Justification

The VIT approach to Biomass and Yield per recruit analysis has been applied in order to analyse the stock production with increasing exploitation under equilibrium conditions.

6.20.6.1.2 Input parameters

The input parameters of the female fraction of the population have been already reported above.

6.20.6.1.3 Results

Estimation of Biomass and Yield per recruit varying current fishing mortality (Fc) by a multiplicative factor is reported in Fig. 6.20.6.1.3.1.

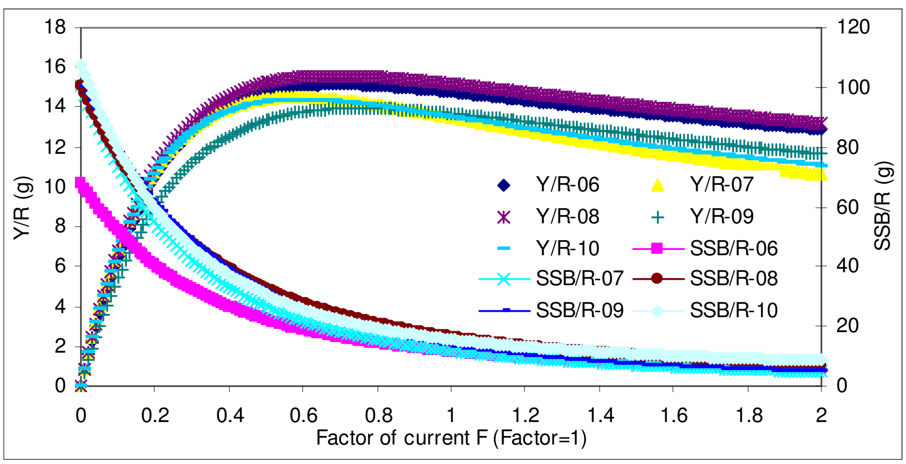


Fig. 6.20.6.1.3.1 Yield (Y/R) and Spawning stock biomass (SSB/R) per female recruit varying current fishing mortality (Fc) by a multiplicative factor according to the VIT package. Analyses deal with pseudo-cohorts 2006, 2007, 2008, 2009 and 2010.

Assuming no variation in the exploitation pattern, the main result of Y/R analysis in terms of current F and optimal ones are reported in Tab. 6.20.6.1.3.1.

Tab. 6.20.6.1.3.1 Estimation of current F, as Fmean, and optimal ones, as F max and F0.1, and corresponding Y, B and SSB per recruits analyses by pseudo cohorts according to VIT package.

	___	Factor	F	Y/R	B/R	SSB
2006	**F(0)**	0.00	0.00	0.00	74.97	68.11
	F(0.1)	0.44	**0.36**	14.41	31.03	24.68
	Fmax	0.71	0.81	15.15	22.45	16.35
	Fc	1.00	1.14	14.77	17.36	11.51
2007	**F(0)**	0.00	0.00	0.00	107.51	100.68
	F(0.1)	0.38	**0.41**	13.82	40.97	34.85
	Fmax	0.59	0.63	14.50	28.67	22.87
	Fc	1.01	1.07	13.50	17.21	12.01
2008	**F(0)**	0.00	0.00	0.00	107.51	100.68
	F(0.1)	0.42	**0.44**	14.72	44.35	37.98
	Fmax	0.70	0.74	15.59	30.50	24.39
	Fc	1.01	1.05	15.17	22.37	16.51
2009	**F(0)**	0.00	0.00	0.00	107.51	100.68
	F(0.1)	0.49	**0.40**	13.30	38.17	32.11
	Fmax	0.76	0.61	13.96	25.49	19.75
	Fc	1.01	0.81	13.69	18.84	13.36
2010	**F(0)**	0.00	0.00	0.00	107.51	100.68
	F(0.1)	0.39	**0.42**	13.73	38.06	31.94
	Fmax	0.60	0.65	14.36	26.15	20.33
	Fc	1.01	1.09	13.51	15.62	10.31

Comparing current F with BRP according to the obtained by VIT steady state VPA a clear overfishing was detected for the female fraction of the population. The current F over age groups 1-4 (median value 2006-2010 being 0.73 is higher than both Fmax (median value 2006-2009 being 0.65) and $F_{0.1}$ (median value 2006-2009 being 0.41).

6.20.6.2 Method 4: Y, B and SSB per recruit according to the Yield package

6.20.6.2.1 Justification

Availability of biological parameter and length at first capture allows to quantify by simulation the likely changes in Y, B and SSB per recruit in function of fishing mortality (F) with the Yield package (Branch et al., 2001). The package was also used to estimate a probability estimation of BRP (F_{max} and $F_{0.1}$).

6.20.6.2.2 Input parameters

Due to the constrains of the package, all parameters were converted from Carapace Length (CL) in mm to Total Length (TL) by using the relation given by Gancitano (Pers. Com.):

LT (mm) = 2.678 CL (mm) + 28.564.

The new parameters were finally converted in terms of cm and g. A guess estimate of uncertainty in terms of coefficient of variation was added to each female parameter (table 6.20.6.2.2.1). Due to the package constrains the natural mortality rate was assumed constant, being M=0.40 (Ragonese et al., 2004). Stock-recruitment relationship was not used. Recruitment was assumed constant with a random variability among years of (CV=0.4).

Table 6.20.6.2.2.1. Parameters used for stock assessment trough Yield approach. Length are in cm and weight in g. Only the female fraction of the fished stock was assessed.

L∞	21.6 (0.1)	Tm	1 (0.1)
K	0.61 (0.1)	Tc	1 (0.1)
t0	-0.2 (0.1)	M	0.40 (0.1)
a	0.0034	Recruitment	Constant with CV=0.4
b	3.3562		

6.20.6.2.3 Results

Estimation of Y and SSB per recruit according to Yield package are shown in Fig 6.20.6.2.3.1.

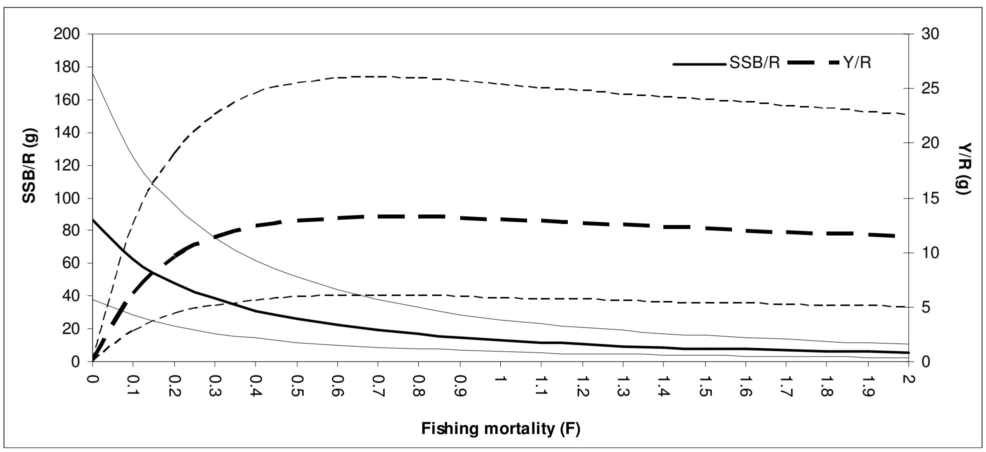


Fig. 6.20.6.2.3.1 Median of yield and spawning stock biomass per recruit and corresponding uncertainty of female giant red shrimps in the GSA 15 and 16 according to the Yield Package.

Searching for biological reference points (BRP) through 2000 simulation produced the probability distribution of Fmax and F0.1 as illustrated in Fig. 6.20.6.2.3.2.

The median value of $F_{0.1}$ = 0.4 should be considered as a proxy for F_{msy}. The $F_{0.1}$ estimate is virtually equal to those given by VIT, whereas Fmax extimated in this manner is thus slightly above that one.

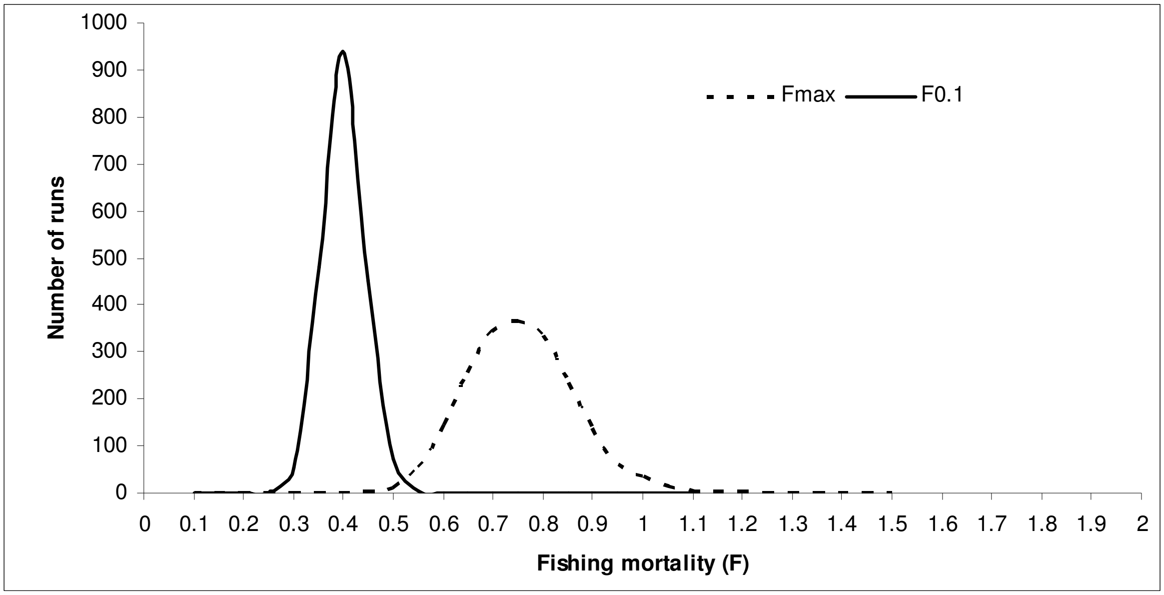


Fig. 6.20.6.2.3.2 Probability distribution of F_{max} and $F_{0.1}$ according to Yield package.

6.20.7 Data quality and availability

STECF EWG 11-12 noted a lack of *A. foliacea* discards data for GSA 16. Erroneously high biomass indices were recorded for giant red shrimp in GSA 15 in 2006: 46.9 kg/h compared to an average of 0.65 kg/h in 2007-2010. This is almost certainly due to an error in raising procedures.

6.20.8 Scientific advice

6.20.8.1 Short term considerations

6.20.8.1.1 State of the spawning stock size

STECF EWG 11-12 estimated the absolute levels of the female stock abundance in 2006-2010 by VIT approach on length structure of Sicilian trawlers which catch about 98% of the total yield in the area. Mean biomass at sea range between 1070 t (2006) and 1580 t (2009), female SSB representing about 70 and 75% of the total population. In the absence of a precautionary biomass reference point STECF EWG 11-12 is unable to fully evaluate the state of the stock size.

6.20.8.1.2 State of recruitment

Absolute estimate of female recruitment (18-22 mm CL) from VIT ranged between 83 (2008) and 123 (2010) millions of recruits.

6.20.8.1.3 State of exploitation

STECF EWG 11-12 proposes F0.1=0.4 (Fmsy proxy) as limit management reference point of the female part of the stock consistent with high long term yield and low risk of fisheries collapse. The female giant red shrimp stock in the Northern sector of the Strait of Sicily is considered overfished since the current fishing mortality F=1.09 exceeds this reference point.

The stock assessments performed during STECF EWG 11-12 confirmed the diagnosis in terms of exploitation state in long term concluded during previous workshops. Considering $F_{0.1}$ as limit reference points, a reduction ranging between 50 and 60 % of the current F in 2009 and 2010 is needed to reach a sustainable fishery exploitation. Thus, EWG reccomends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

6.20.8.2 Medium term considerations

The EWG was informed that the Italian government is adopting a management plan in which a reduction of trawling capacity of 25% by 2013 is foreseen as compared with 2008. STECF EWG 11-12 recommends the adoption of a management plan to continuously reduce current F through consistent effort.

6.21 Stock assessment of Common Pandora in GSAs 15 and 16

6.21.1 Stock identification and biological features

6.21.1.1 Stock Identification

Pagellus erythrinus is a widely distributed species in the Sparidae family, which is found in the north-eastern and central-eastern Atlantic Ocean, from Norway (Bauchot and Hureau, 1986) to Guinea-Bissau (Sanches, 1991 in Coelho et al. 2010) and the Mediterranean Sea (Spedicato et al. 2002). In the Mediterranean it occurs on continental shelf bottoms throughout all Mediterranean basins, including the Black Sea. Although aspects of Common Pandora population biology and fisheries have been the subject of several studies (e.g. Santos et al. 1995, Pajuelo and Lorenzo 1998, Hossucu 2003, Klaoudatos 2004, Metin et al. 2011), no detailed information on stock structure is available from the Central Mediterranean. Cannizzaro et al. (1994) identified nursery areas on the GSA 16 and 15, with the exclusion of the MFMZ (Fig. 6.21.1.1.1).

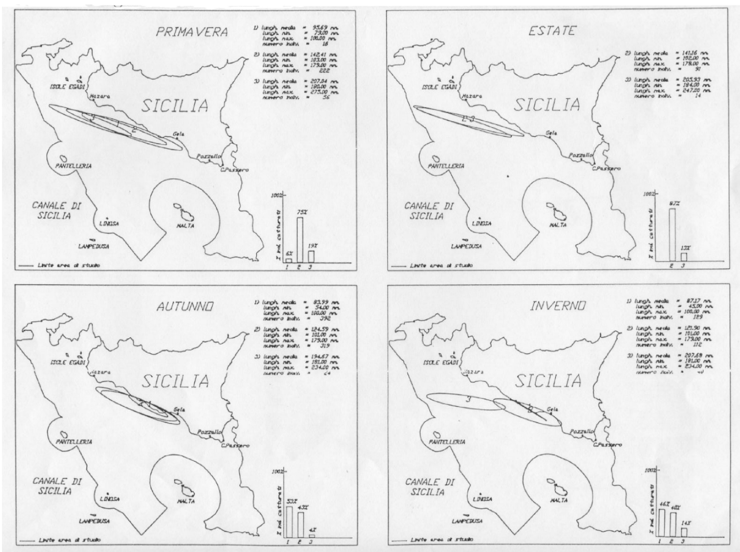


Fig. 6.21.1.1.1 *P. erythrinus* nursery areas with individuals smaller than 10cm in the Strait of Sicily, based on 1985-87 data (from Cannizzaro et al., 1994).

6.21.1.2 Growth

The Von Bertalanffy Growth Function parameters by sex available in the scientific literature are reported in Table 6.21.1.2.1, and length weight relationship parameters in Table 6.21.1.2.2.

Table 6.21.1.2.1 Von Bertalanffy growth function parameters of *P. erythrinus*. Length is in mm.

			Females & Males		
Author	**Area**	**Data Source**	L_{inf}	**k**	t_0
Ragonese et al., 2004	Strait of Sicily	MEDITS Trawl survey data	380	0.18	-0.71
Gancitano et al., 2010a	Strait of Sicily	Commercial trawl / trammel / longline data	465	0.09	-2.99

Table 6.21.1.2.2 *P. erythrinus* length-weight relationship parameters. Parameters given by Ragonese et al. (2004) are in mm, parameters given by Gancitano et al. (2010b) are in cm.

		Females		Males		Combined	
Author	**Area**	**a**	**b**	**a**	**b**	**a**	**b**
Ragonese et al., 2004	Strait of Sicily	0.000043–0.0000288	2.78–2.85	0.0000347–0.0000221	2.81–2.91		
Gancitano et al., 2010b	Strait of Sicily					0.0216	2.8299

Andaloro & Giarritta (1985) described firstly the growth of the species in the area on the basis of trawling catches. Orsi Relini & Romeo (1985) reported difference in growth patterns between specimens caught by trawling and those caught by long lines. Gancitano et al. (2010a) studied the existence of differences in growth curves of *P. erythrinus* in GSA 16 based on data from commercial trawling and artisanal fisheries (trammel net and long lines). In this study a total of 2647 otoliths ($945_{trawling}$; $563_{artisanal}$ from females and $758_{trawling}$; $381_{artisanal}$ from males) were sampled and age was estimated by reading whole sagitta under transmitted light. Since this species is a protogynous hermaphroditic species, the von Bertalanffy growth curves (VBGF) were estimated by combined sex and keeping the metiers separate using the "Length at Age" routine as implemented in Fisat II. The results showed that differences in VBGF parameters by metier (Table 6.21.1.2.3) were significant ($p<0.05$; F=54.94).

Table 6.21.1.2.3. Growth parameters of *P. erythrinus* by single and combined metiers (from Gancitano et al. 2010a)

Growth parameters	Combined trawling	Combined artisanal	Combined gears
N	1703	944	2647
L_∞	24.04	48.93	46.48
$se(L_\infty)$	1.282	7.111	10.59
k	0.511	0.088	0.09
$se(k)$	0.202	0.034	0.066
t_0	-0.84	-3.06	-2.99
$se(t_0)$	n.c	n.c	n.c

Moreover, specimens caught by artisanal gears were larger at a given age than those caught by trawling (Fig. 6.21.1.2.1).

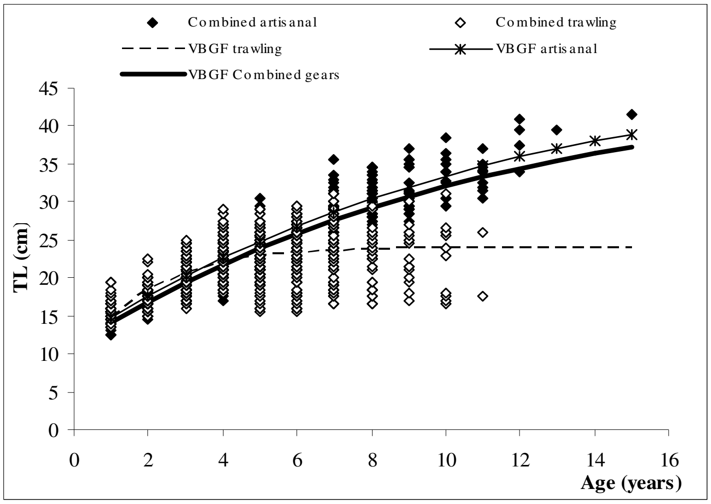


Fig. 6.21.1.2.1 Length at age and VBGC of *P. erythrinus* by single and by combined gears (from Gancitano et al. 2010a).

The difference in exploitation pattern of trawling and artisanal fisheries suggests that more realistic growth parameters have to be obtained by integrating information coming by different sources.

6.21.1.3 Maturity

P. erythrinus is a protogynous hermaphroditic species, where large fish change sex from females to males. Several authors have reported that the sex ratio of *P. erythrinus* in the Mediterranean is skewed in favour of females due to a lack of large individuals (Pajuelo and Lorenzo 1998; Vassilopoulo et al. 1986; Hashem and Gassim, 1981; Unsal, 1984; Mytilineou, 1989; Ozaydın 1997 in Hossucu 2003; Hoşsucu and Cakır, 2003), a situation which has important management implications.

The length at 50% maturity has been reported at 120-130 mm for females and 160 – 170 mm for males by Ragonese et al. (2004). Fiorentino et al. (2005) estimated the maturity oogive for females in GSA 16, and estimated an Lm of 160 mm (Fig. 6.21.1.3.1)

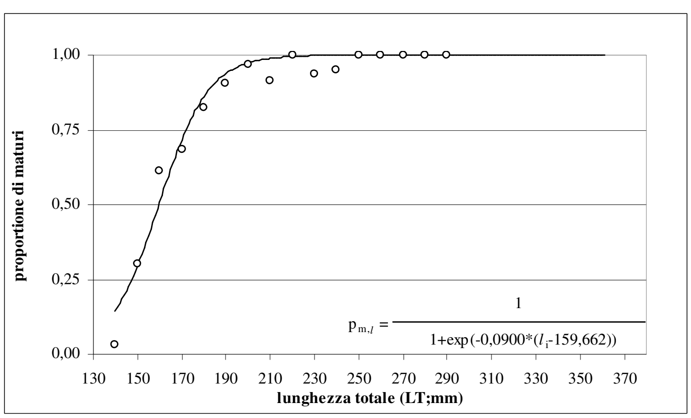


Figure 6.21.1.3.1 Ogiva di maturità delle femmine di pagello fragolino con indicata una stima della lunghezza di maturità al 50% (L_m= 160 mm LT) nella GSA 16.

With regards the timing of the reproductive season, Giudicelli (1982, in Fiorentino et al. 2005) reported that the reproductive peak for *P. erythriuns* in the Gulf of Tunis is between May and August. Similarly Ragonese et al. (2004) reported the spawning season for *P. erythriuns* off the Sicilian southern coasts to occur in spring-summer.

6.21.2 Fisheries

6.21.2.1 General description of fisheries

Common Pandora is an important demersal fishery resource through the Mediterranean, including in the Strait of Sicily (Gancitano et al. 2010b). Trawling is carried out on the continental shelf of the Central Mediterranean throughout the year, and catches include common Pandora (*Pagellus erythrinus*), pink shrimp (*Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*), giant red shrimp (*Aristaeomorpha foliacea*), violet shrimp hake (*Merluccius merluccius*), violet shrimp (*Aristeus antennatus*), scorpionfish (*Helicolenus dactylopterus*), grater forkbeard (*Phicys blennioides*), red Pandora (*Pagellus bogaraveo)* and monkfish (*Lophius piscatorius*). In addition to trawling, common Pandora is targeted by several artisanal gears, including set gillnets, trammel nets, pots and traps and set longlines.

6.21.2.2 Management regulations applicable in 2010 and 2011

At present there are no formal management objectives for Common Pandora in the Strait of Sicily fisheries. As in other areas of the Mediterranean, the stock management is based on control of fishing capacity (licenses), fishing effort (fishing activity), technical measures (mesh size and area/season closures).

The adoption of the trawling ban of 30-45 days per year by the Sicilian Government since late eighties have should contributed to reduce the fishing effort on demersal resources off the Sicilian coast. However this measure for many years had low efficacy in Sicily because the period of stopping trawling was not chosen to reduce fishing mortality on juveniles (late summer-early autumn). Since 2008 the seasonal trawling ban for Sicilian trawlers was done in September–October contributing to improve the stock status of common pandora.

In order to limit the over-capacity of fishing fleet, no new fishing licenses have been assigned in Italy since 1989, and a progressive reduction of the trawl fleet capacity is occurring. Maltese fishing licenses have been fixed at a total of 16 trawlers since 2000. Eight new licences were however issued in 2008, a move made possible under EU law by the reduction of the capacities of other Maltese fishing fleets.

In terms of technical measures, the new regulation EC 1967 of 21 December 2006 fixed a minimum mesh size of 40 mm for bottom trawling of EU fishing vessels (Italian and Maltese trawlers). Mesh size had to be modified to square 40 mm or diamond 50 mm in July 2008, and derogations were only possible up to 2010.

The minimum marketable size of *P. erythrinus* is fixed at 15cm by EC 1967/2006.

The Maltese Islands are surrounded by a 25 nautical miles (nm) fisheries management zone, where fishing effort and capacity are being managed by limiting vessel sizes, as well as total vessel engine powers (EC 813/04; EC 1967/06). Trawling is allowed within this designated conservation area, however only by vessels not exceeding an overall length of 24m and only within designated areas. Such vessels fishing in the management zone hold a special fishing permit in accordance with Article 7 of Regulation (EC) No 1627/94, and are included in a list containing their external marking and vessel's Community fleet register number (CFR) to be provided to the Commission annually by the Member States concerned. Moreover, the overall capacity of the trawlers allowed to fish in the 25nm zone can not exceed 4 800 kW, and the total fishing effort of all vessels is not allowed to exceed an overall engine power and tonnage of 83 000 kW and 4 035 GT respectively. The fishing capacity of any single vessel with a license to operate at less than 200m depth can not exceed 185 kW. In addition, the use of all trawl nets within 1.5nm of the coast is prohibited according to EC regulation 1967 / 2006, although again a transitional derogation is at present in place until 2010.

6.21.2.3 Catches

6.21.2.3.1 Landings

Table 6.21.2.3.1. Annual *P. erythrinus* landings (t) by fishing technique in GSAs 15 and 16 as reported to STECF EWG 11-12 through the DCF data call.

COUNTRY	GEAR	2006	2007	2008	2009	2010	Grand Total
ITA	GNS					0.27	0.27
	GTR	135.1	16.1	19.32	32.25	15.49	67.06
	LLS			21.39	29.53	9.27	60.19
	OTB	777.26	465.35	361.50	223.27	273.94	858.70
ITA Total		**912.32**	**481.42**	**402.21**	**285.04**	**298.97**	**986.22**
MLT	FPO	0.00	0.02	0.02	0.01		0.04
	GNS	0.00			0.04		0.04
	GTR	1.55	0.94	1.01	0.94	2.38	6.83
	LHP	0.02			0.06		0.08
	LLS	2.64	2.47	4.36	1.18	10.63	21.27
	OTB	0.98	2.89	3.93	8.52	7.11	23.42
MLT Total		**5.19**	**6.31**	**9.32**	**10.74**	**20.11**	**51.68**
Grand Total		**917.51**	**487.73**	**411.53**	**295.79**	**319.08**	**1037.90**

6.21.2.3.2 Discards

No official information on Common Pandora discards data from GSAs 15 / 16 was available to STECF EWG 11-12.

6.21.2.4 Fishing effort

The effort by main fishing technique and segment deployed in GSA 15 & 16, keeping separate the Italian and Maltese fleet, as reported to STECF EWG 11-12 through the DCF data call is showed in Fig. 6.21.2.4.1. The segment of the Italian demersal otter trawl reveals a 20% decrease for vessels larger than 24m in 2008-2010 compared to 2004-2007. A decreasing pattern was also clear for the Italian boats equipped with trammel-nets.

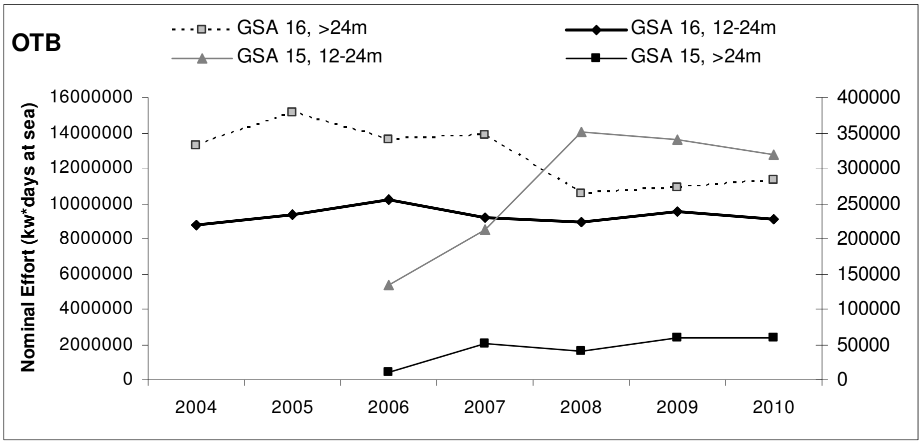


Fig. 6.21.2.4.1. Nominal effort (kW*days at sea) trends of trawlers (OTB) by segments in GSA 15 (left) & 16 (right), 2004-2010.

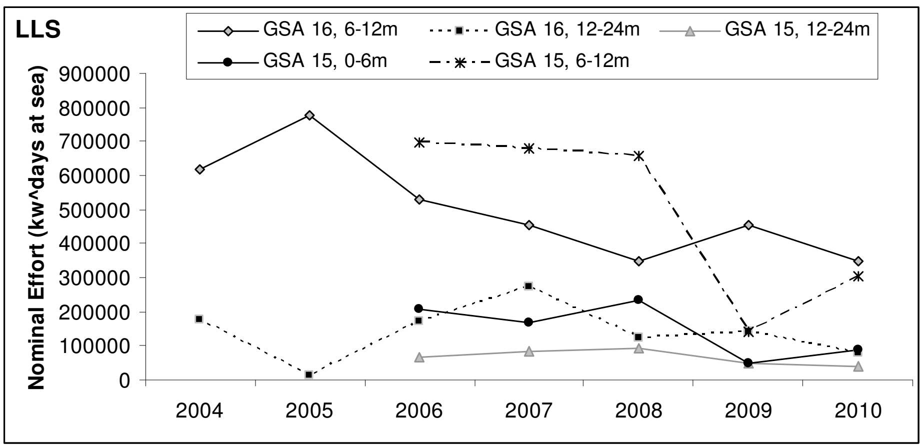


Fig. 6.21.2.4.2. Nominal effort (kW*days at sea) trends of artisanal fisheries (LLS – set lonlines) segments in GSA 15 & 16, 2004-2010.

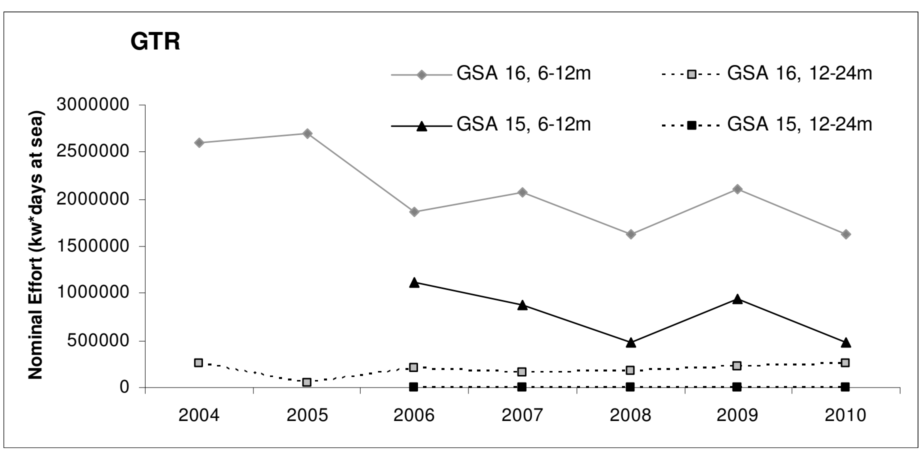


Fig. 6.21.2.4.3. Nominal effort (kW*days at sea) trends of artisanal fisheries (GRT- trammel nets) segments in GSA 15 & 16, 2004-2010.

6.21.3 Scientific surveys

6.21.3.1 Medits

6.21.3.1.1 Methods

Based on the DCF data call, abundance and biomass indices were recalculated and presented in section 11 of this report.

In order to collect fisheries independent data, which is a requirement of the EU DCF (Council Regulation 199/2008, Commission Regulation 665/2008, Commission Decision EC 949/2008 and Commission Decision 93/2010), the MEDITS international trawl survey is carried out in GSAs 15 and 16 on an annual basis. The following number of hauls was reported per depth stratum in 1994-2009 (GSA 16) and 2002-2010 (GSA 15):

Tab. 6.21.3.1.1.1. Number of hauls per year and depth stratum in GSA 16, 1994-2010.

Depth (m)	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
10-50	4	4	4	4	4	4	4	4	7
50-100	8	8	8	8	8	8	7	8	11
100-200	4	4	4	4	5	5	6	5	10
200-500	10	11	11	12	11	11	11	11	19
500-800	10	14	14	13	14	14	14	14	19
Depth (m)	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	
10-50	7	7	10	10	11	11	11	11	
50-100	12	12	20	22	23	23	23	23	
100-200	8	9	18	19	21	21	21	21	
200-500	18	19	28	31	27	27	27	27	
500-800	20	19	32	33	38	38	38	38	

Tab. 6.21.3.1.1.2. Number of hauls per year and depth stratum in GSA 15, 2002-2010.

Depth (m)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
10-50	1	1	2	1	1	0	0	0	0
50-100	5	5	4	5	5	12	6	6	6
100-200	13	13	13	13	13	12	13	14	14
200-500	10	10	10	9	10	4	9	10	10
500-800	16	16	15	17	16	17	17	15	15

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). A limited number of obvious data errors were corrected and catches by haul were standardized to 60 minutes haul duration. Only hauls noted as valid were used, including stations with no catches of hake, red mullet or pink shrimp (i.e. zero catches were included).

The abundance and biomass indices were subsequently calculated by stratified means (Cochran, 1953; Saville, 1977). This implies weighing average values of the individual standardized catches as well as the variation of each stratum by the respective stratum area:

$Yst = \Sigma (Yi*Ai) / A$ $V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A = total survey area
Ai = area of the i-th stratum

si = standard deviation of the i-th stratum
ni = number of valid hauls of the i-th stratum
n = number of hauls in the GSA
Yi = mean of the i-th stratum
Yst = stratified mean abundance
V(Yst) = variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t (student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions about the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.* 2004).

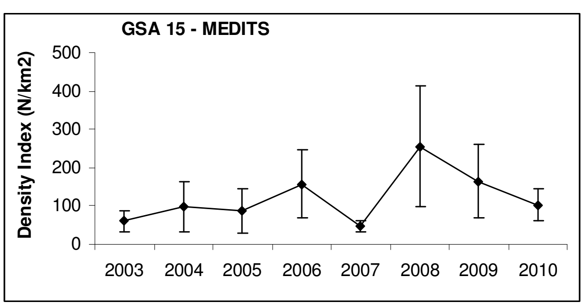
Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.21.3.1.2 Geographical distribution patterns

P. erythrinus inhabits the continental shelf bottoms of the Strait of Sicily. Whilst Common Pandora can be found at depths of up to 300m, they are most common at depths from 20-100m (Santos et al., 1995). No maps of the geographic distribution patterns other than those presented in the stock identification section above are at present available for GSAs 15 and 16.

6.21.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the common Pandora was derived from the international survey MEDITS as well as GRUND. Figure 6.21.3.1.3.1 displays the estimated trend in *P. erythrinus* MEDITS abundance and biomass at depths of 10-200m in GSA 15, Figure 6.21.3.1.3. 2 displays the estimated trend in MEDITS abundance and biomass on the shelf of GSA 16, and Figure 6.21.3.1.3.3 displays the estimated trend in GRUND abundance and biomass on the shelf of GSA 16.



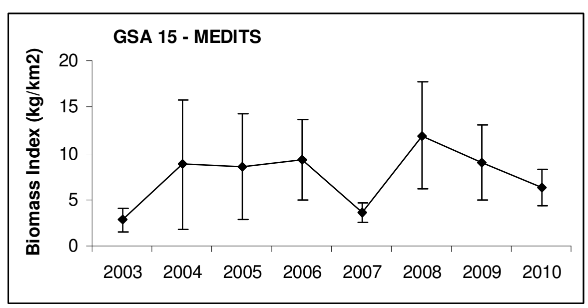
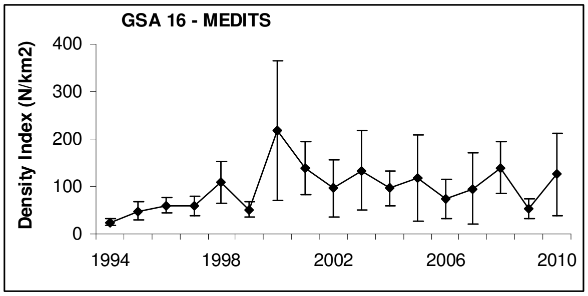


Fig. 6.21.3.1.3.1 MEDITS abundance and biomass indices of common Pandora in GSA 15.



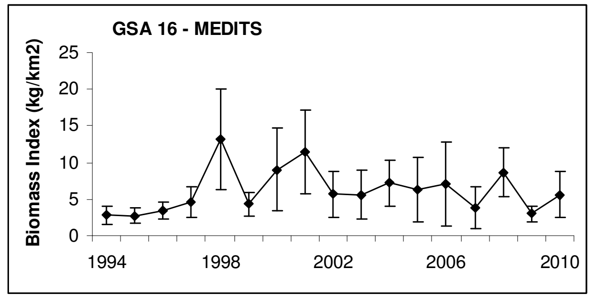
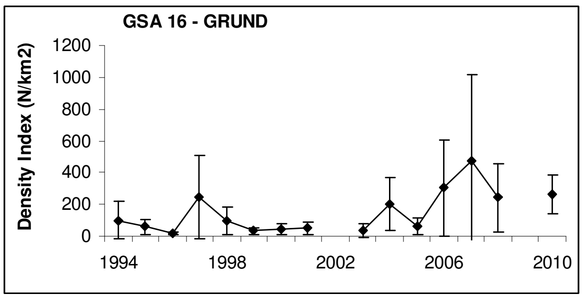


Fig. 6.21.3.1.3.2 MEDITS abundance and biomass indices of common Pandora in GSA 16.



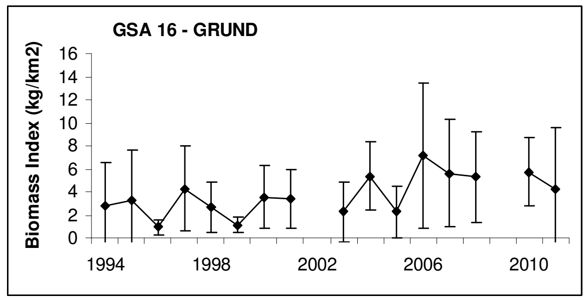


Fig. 6.21.3.1.3.4 GRUND abundance and biomass indices of common Pandora in GSA 16.

The time series of recruitment indices (age class 0) from trawl surveys in autumn (GRUND surveys) carried out in GSA 16 (individuals smaller than 15 cm TL) showed a wide fluctuation, without any clear trend.

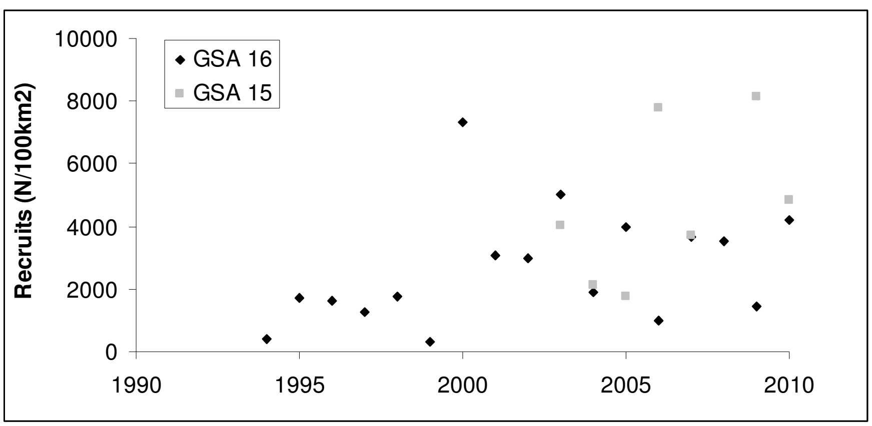


Fig. 6.21.3.1.3.4 Recruit indices derived from scientific surveys in spring / summer (MEDITS). This fish are about 12 month old.

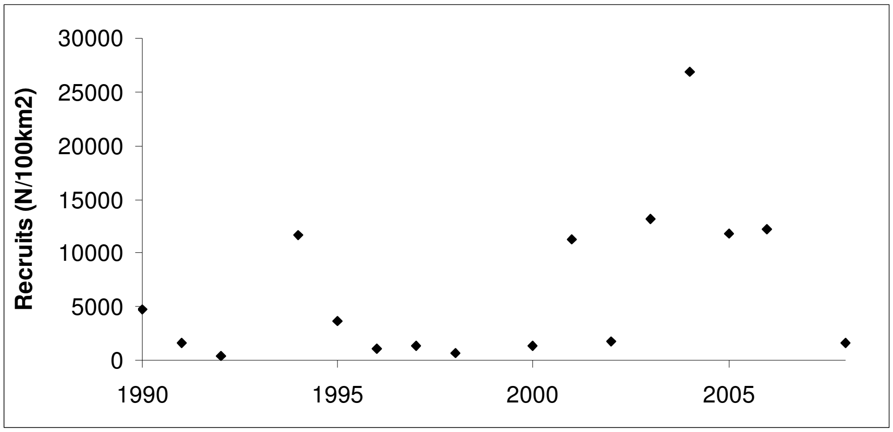
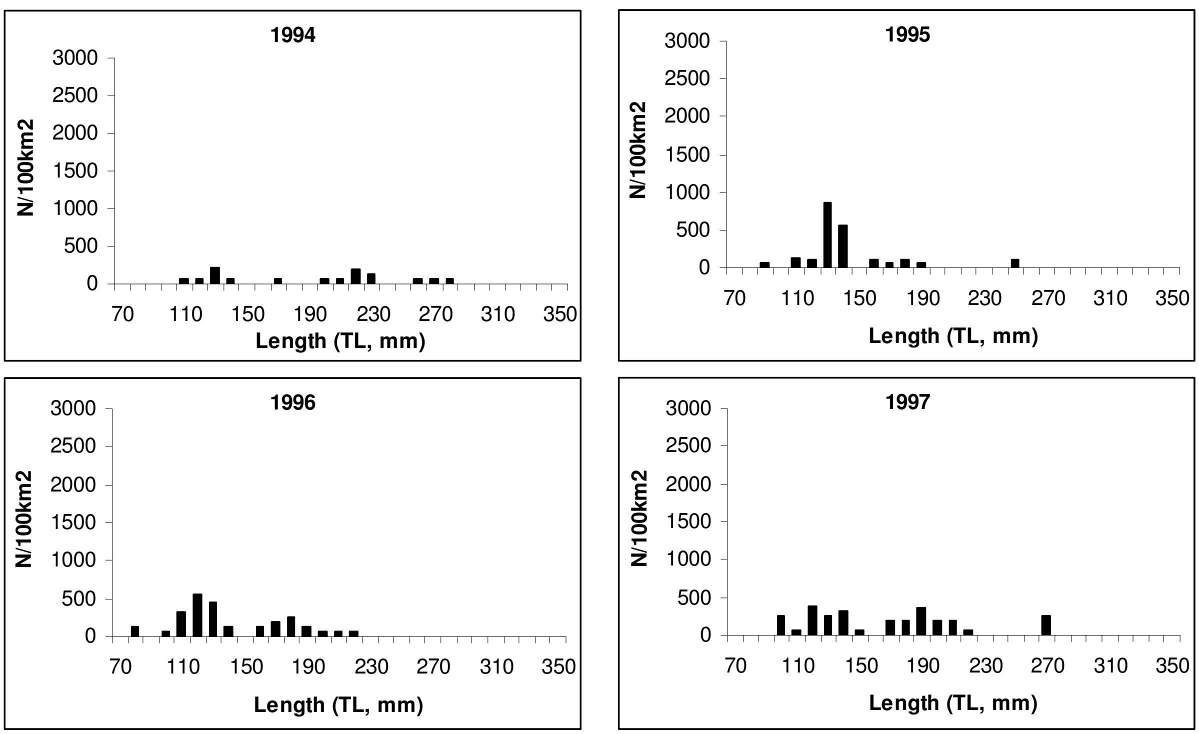
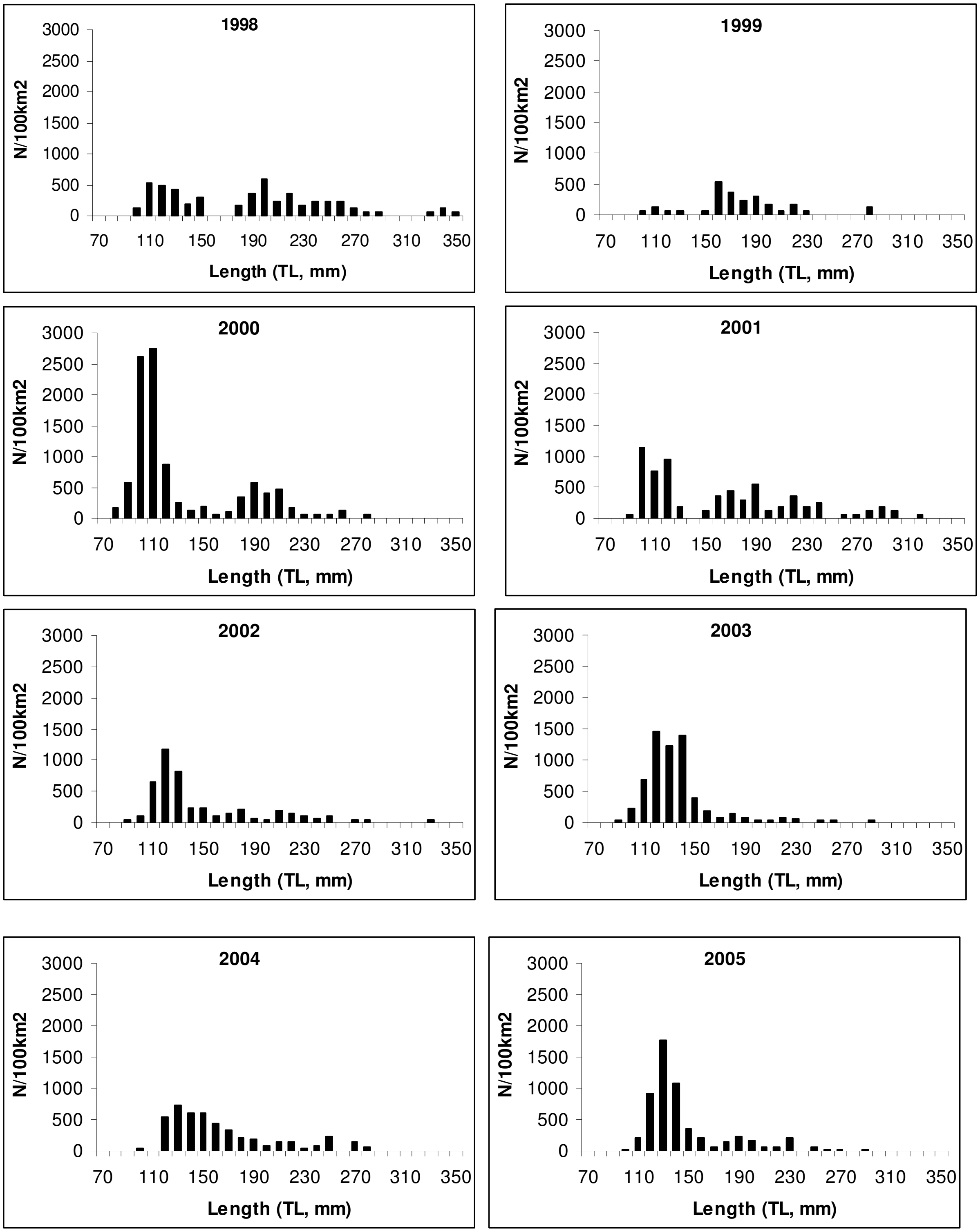


Fig. 6.21.3.1.3.5 Recruit indices derived from scientific surveys in autumn (GRUND). This fish are about 6 month old.

6.21.3.1.4 Trends in abundance by length or age

Fig. 6.21.3.1.4.1 displays the *P. erythrinus* MEDITS abundance indices by size in 1994-2010 for GSA 16, and Fig. 6.21.3.1.4.2 the MEDITS abundance indices by size in 2002-2010 for GSA 15.




1998
1999
2000
2001
2002
2003
2004
2005
N/100km2
0
500
1000
1500
2000
2500
3000
70
110
150
190
230
270
310
350
Length (TL, mm)

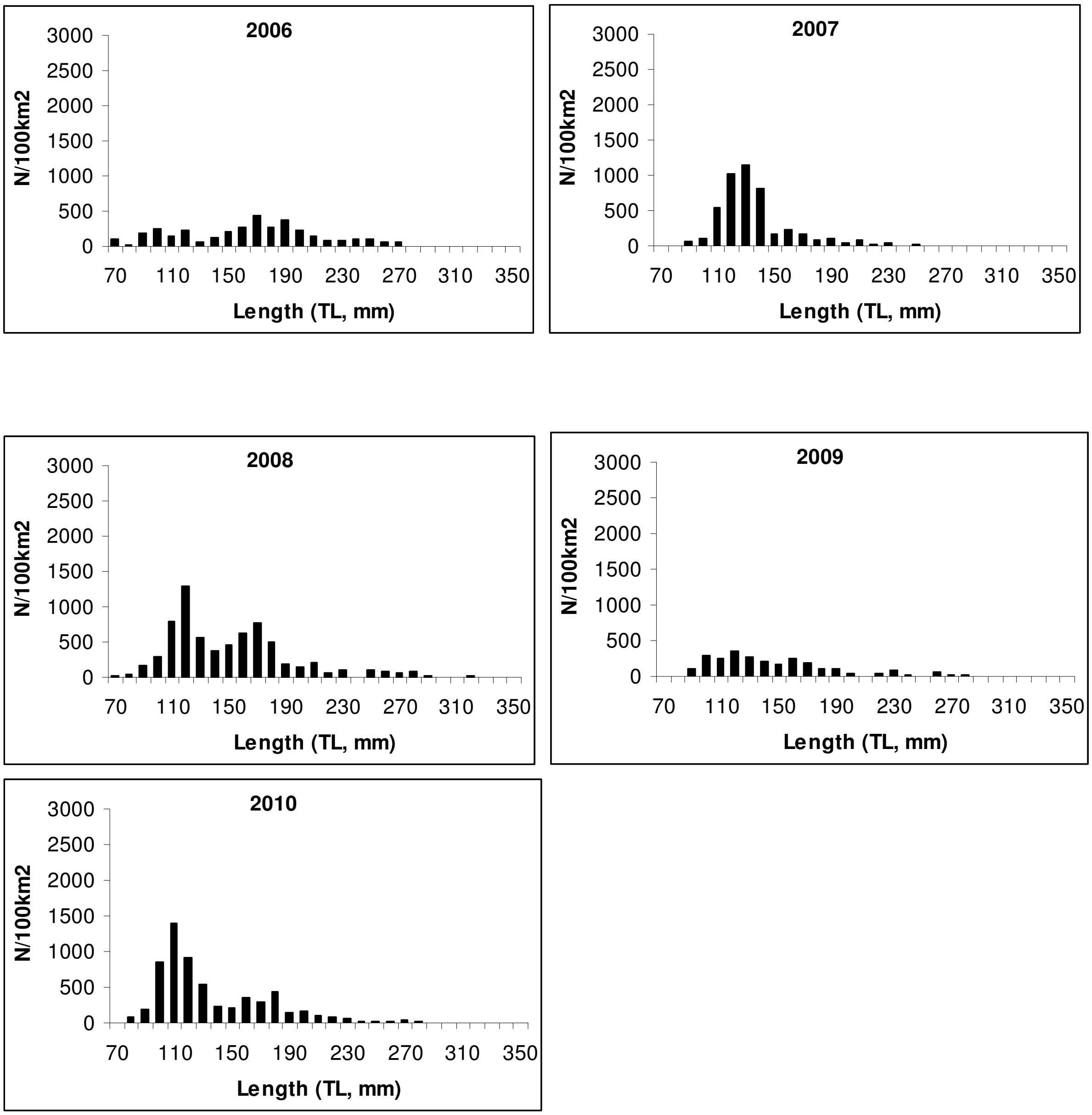


Fig. 6.21.3.1.4.1 Standardised MEDITS length frequency distributions of *P. erythrinus* recorded in GSA 16 in 1994-2010.

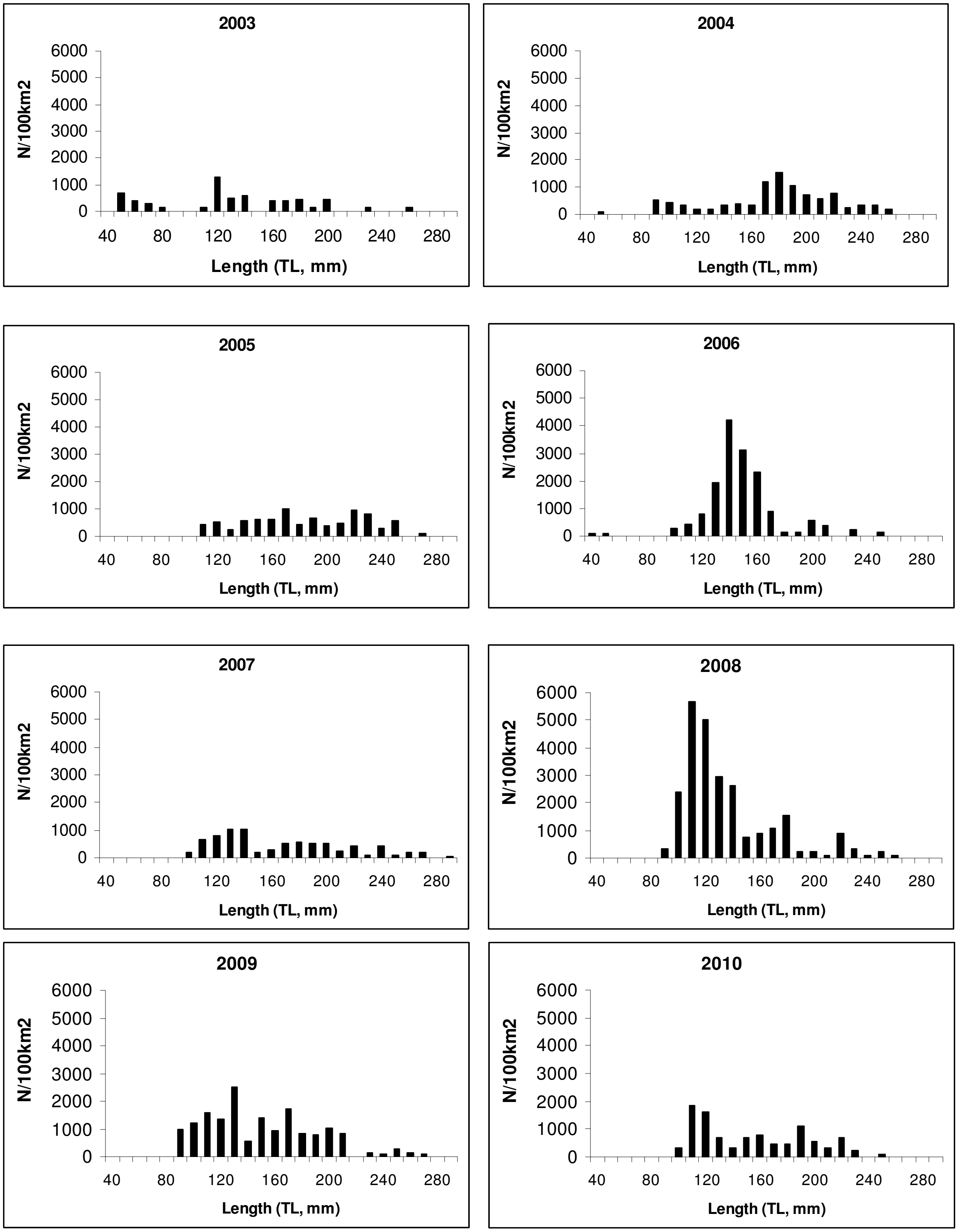


Fig. 6.21.3.1.4.2 Standardised MEDITS length frequency distributions of *P. erythrinus* recorded in GSA 15 in 2002-2010.

6.21.3.1.5 *Trends in growth*

No analyses were conducted during STECF EWG 11-12.

6.21.3.1.6 *Trends in maturity*

No analyses were conducted during STECF EWG 11-12.

6.21.4 *Assessment of historic stock parameters*

Gancitano et al. (2010b) assessed the current exploitation of *P. erythrinus* in the Strait of Sicily (GSA 16) by age cohort and yield and biomass per recruit analysis using data from commercial trawling and artisanal fisheries (trammel net and long lines) averaged from 2007 to 2009. Due to the fact that common Pandora is a protogynous hermaphroditic species, the combined sex length composition of landings were prepared by sex combined. The LFDs were subsequently changed into numbers at age group using the "age slicing" by LFDA package; (Kirkwood *et al.,* 2001). Current exploitation levels were assessed by age cohort analysis as implemented in the VIT for Windows package (Lleonart and Salat, 2000); yield and biomass per recruit and BRP (F_{max}, $F_{0.1}$ and F_{ssb}) were estimated by YIELD package (Branch *et al*., 2000).

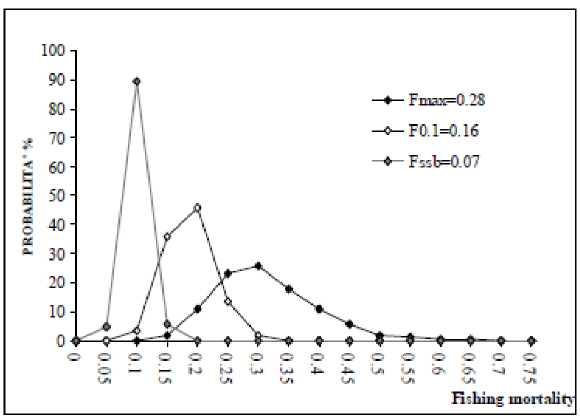
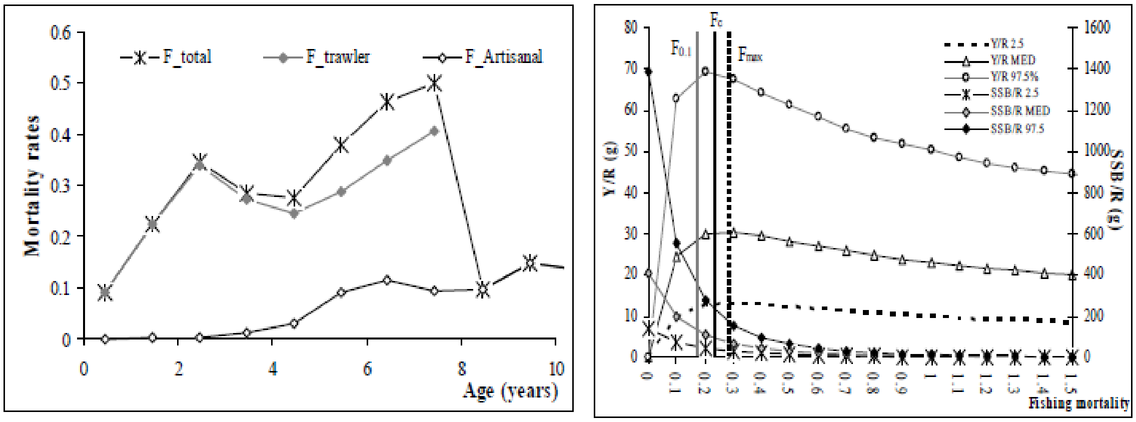


Fig. 6.21.4.1 Fmax, F0.1 and FSSB 0.35 values obtained in 3000 runs of the Yield package (after Gancitano et al. 2010b).

The assessment results showed that the current values of F, averaged over age classes that accounted for 90% of the catch, were 0.23 in trawlers, 0.04 in artisanal fisheries and 0.24 when combining metiers.



A) B)

Fig. 6.21.4.1 A) *P. erythrinus* fishing mortality by age class and metier; B) Y/R and SSB/R analysis results of *P. erythrinus* assessment (after Gancitano et al. 2010b).

Since these values were between the limit reference point Fmax=0.28 and the target reference point F0.1=0.16, the resource is overfished. A 50% reduction of current fishing mortality rates was suggested in order to reach a more sustainable exploitation state of this species.

6.21.4.1 Method 1: LCA (VIT)

6.21.4.1.1 Justification

Five complete years (2006, 2007, 2008, 2009 and 2010) of length frequency distributions from GSA 16 commercial landings data (fished in GSA 15 as well as GSA 16) were available, so an approach under steady state (pseudocohort) assumptions was used. Cohort (VPA equation) and Y/R analysis as implemented in the package VIT4win were thus used (Lleonart and Salat, 2000). Data were derived from the DCF data call for GSA 16.Total landing included the yield of Maltese fleet.

6.21.4.1.2 Input parameters

The used parameters were reported in table 6.21.4.1.2.1.

Tab. 6.21.4.1.2.1 Common Pandora growth parameters used in yield and SSB per recruit analysis

Linf	k	t0	A	b
40.0	0.176	-1.00	0.0220	2.8300

The maturity was fixed at 2 y and natural mortality at 0.29 (Gancitano et al., 2010b). Terminal F was fixed as 0.5. Discard data was not included in the analysis.

Tab. 6.21.4.1.2.2 LFD of commercial *P. erythrinus* landings data from GSA 16 by gear used as input data for age slicing and subsequently VIT analysis.

	Trawler					Artisanal (trammels & longlines)				
TL (cm)	**2006**	**2007**	**2008**	**2009**	**2010**	**2006**	**2007**	**2008**	**2009**	**2010**
13	0	0	0	0	211	0	2406	0	0	4479
14	0	15409	6894	2073	1519	0	5964	1034	0	9395
15	0	118446	57178	113021	14558	0	7738	0	0	4479
16	33903	412955	229331	168550	51198	0	7758	0	0	4479
17	330210	506704	410490	177588	59689	0	9681	682	0	6719
18	588391	492628	435879	186744	49266	18385	2282	2387	0	436
19	542817	516951	407982	233016	43664	48544	2621	1476	11614	6719
20	292236	372569	410576	125588	36478	21916	4029	3932	3058	5788
21	182843	274627	277289	123816	36461	15560	4626	6682	5527	2240
22	345435	324442	278175	141347	43420	42188	5508	5530	16126	3985
23	165223	268304	141523	149824	33635	9447	7095	6716	3951	3985
24	222479	231231	127392	81634	25045	13311	11423	11240	5863	7155
25	140172	151037	57418	35857	16587	11917	12378	13619	25350	8465
26	67372	83284	41893	35761	7395	10715	1984	16238	17768	1745
27	54845	44268	31519	24026	12999	4618	5213	6871	26062	3985
28	33251	13728	10248	11149	3688	8401	5418	3937	19527	873
29	16059	10854	6584	12503	2518	0	4413	4732	6554	436
30	7688	0	1511	0	534	13047	3288	2757	5206	436
31	0	0	3527	2170	534	0	2486	2590	4742	0
32	0	0	0	0	0	1172	1408	1256	3247	0
33	0	0	0	0	0	1172	1141	1332	10541	0
34	0	0	0	0	0	2173	0	2086	0	0
35	0	0	0	0	0	6691	1238	4670	1164	0
36	0	0	0	0	0	0	0	930	1164	436
37	0	0	0	0	0	0	0	1861	0	0
38	0	0	0	0	0	0	0	413	1164	0
39	0	0	0	0	0	0	0	930	1164	0
40	0	0	0	0	0	0	0	1861	0	0
41	0	0	0	0	0	0	0	930	0	0
total	3022923	3837435	2935410	1624668	439400	229257	110099	106694	169789	76238

6.21.4.1.3 Results

Fishing mortality rates (F) for combined sexes by year and gear (1 – trawler and 2 artisanal) are shown in Fig. 6.21.4.1.3.1 below.

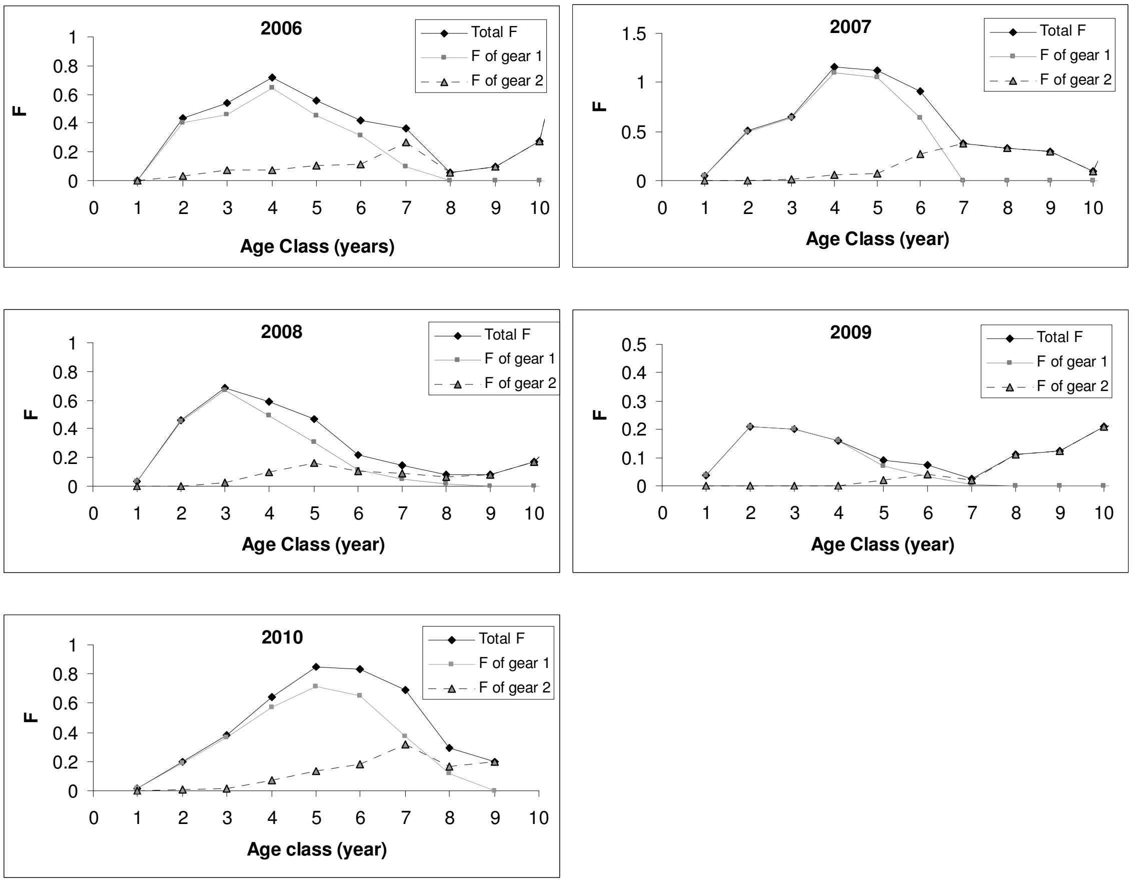


Fig. 6.21.4.1.3.1. Fishing mortalities rates (F) by age and gear for combined sexes of *P. erythrinus*.

Table 6.21.4.1.3.1 The main results of VIT analysis (GSA 16).

Variables	2006	2007	2008	2009	2010
Observed Yield (tons)	912	488	411	295	251
Reconstructed Yield (tons)	912	488	411	218	251
Estimated recruitment (ml)	15.2	8.1	7.1	5.1	3.9
Mean F (2-7)	0.58	0.75	0.54	0.21	0.72

6.21.5 Short term prediction

No short term prediction were performed by STECF EWG 11-12 .

6.21.6 Long term prediction

6.21.6.1 Justification

VIT estimations and results of YpR are adopted to derive reference points.

6.21.6.2 Justification

Input parameters are identical to those used in the VIT assessments given above.

6.21.6.3 Results

The annual results of the YpR are illustrated and tabled below.

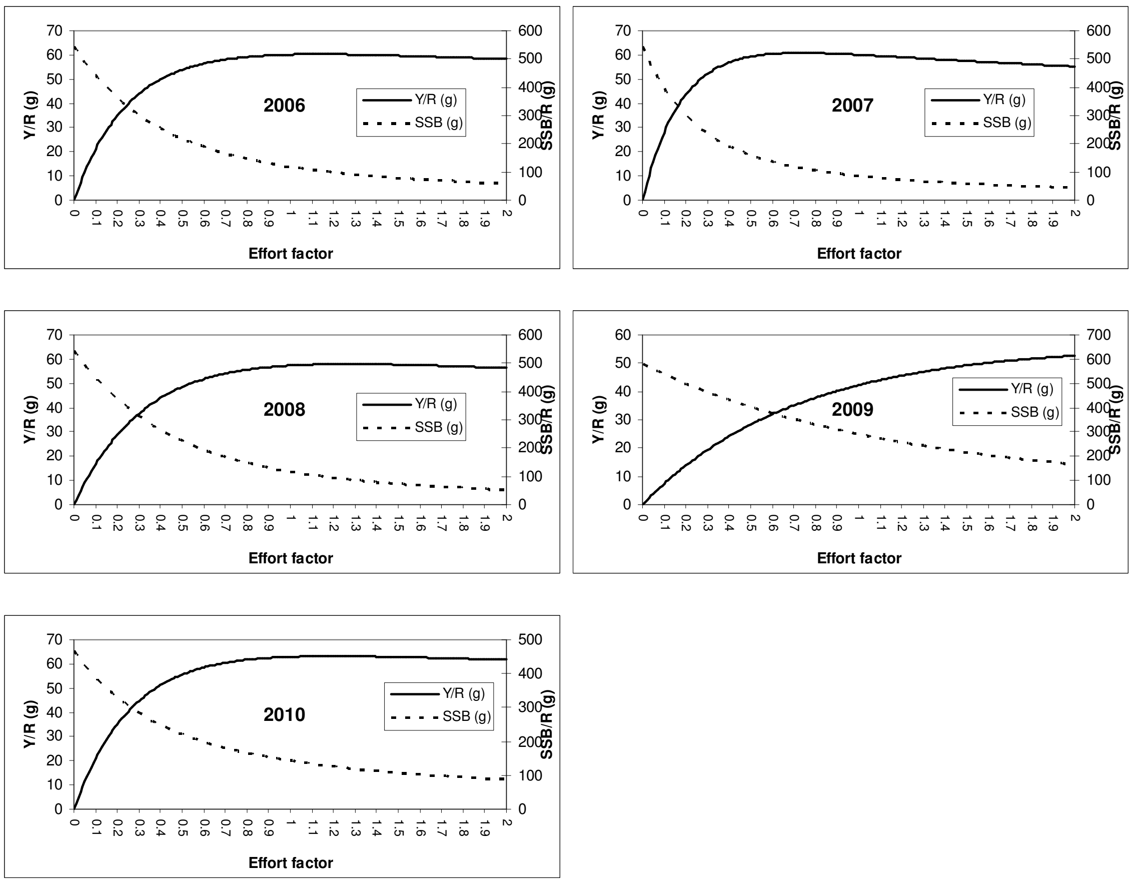


Fig. 6.21.6.3.1 Yield and Spawning Stock Biomass per recruit under varying current fishing mortality (Fc) according to the VIT package (combined sex).

Tab. 6.21.6.3.1. Estimation of yield (Y in g), biomass (B in g) and spawning stock biomass (SSB in g) per recruit (R), varying current fishing mortality by a multiplicative factor (combined sex). The factor corresponding to F0.1 is marked in bold and the current status is underlined.

	Factor	Absolute F	Y/R	B/R	SSB	Y/R 12_24	Y/R >24
2006	0.00	0.00	0.00	577.21	542.34	0.00	0.00
	0.56	**0.28**	55.54	234.17	199.32	43.51	12.04
	1.01	0.51	60.15	153.54	118.70	51.13	9.02
	1.14	0.58	60.28	140.08	105.25	51.92	8.36
2007	0.00	0.00	0.00	577.21	542.34	0.00	0.00
	0.39	**0.31**	56.54	229.04	194.55	49.24	7.31
	0.74	0.58	60.83	148.68	114.51	57.00	3.83
	1.01	0.80	60.07	120.06	86.14	57.67	2.40
2008	0.00	0.00	0.00	577.21	542.34	0.00	0.00
	0.71	**0.30**	54.28	200.73	166.25	46.14	8.13
	1.01	0.43	57.39	150.97	116.65	51.07	6.31
	1.28	0.55	57.97	123.15	88.98	53.18	4.80
2009	*0.00*	*0.00*	*0.00*	*615.18*	*580.31*	*0.00*	*0.00*
	1.01	*0.14*	*42.27*	*325.03*	*290.83*	*30.44*	*11.84*
	1.66	***0.23***	*50.63*	*232.10*	*198.33*	*40.63*	*10.01*
2010	0.00	0.00	0.00	499.06	464.18	0.00	0.00
	0.60	**0.36**	58.55	233.61	198.95	50.02	8.53
	1.01	0.60	62.94	177.64	143.12	56.01	6.92
	1.21	0.72	63.21	160.71	126.26	57.01	6.20

The Y/R analyses resulted highly consistent throughout the years, with the exception of 2009 when the curve increase with an anomalous pattern and without a clear maximum.

6.21.7 Data quality and availability

Landings length frequency distributions are anomalous for 2009, and as a result assessment results for 2009 are inconsistent with results obtained for 2006-2008 and 2010. Based on the pattern of the length frequency distribution it is likely that an error was made during raising procedures; this should be verified and corrected. The relevant data sheet to be verified is Italian fisheries landings at length data for 2009, trammel and longline gear, GSA 16, *Pagellus erythrinus*.

6.21.8 Scientific advice

6.21.8.1 Short term considerations

6.21.8.1.1 State of the spawning stock size

According to VIT analysis, absolute estimations of SSB (combined sex) in the 2006-2009 was 1070 t in 2006, 1307 t in 2007, 1046 t in 2008, 905t in 2009 and 1072 t in 2010. Since the value of 2009 are not consistent, the parental stock seems to be quite stable. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

6.21.8.1.2 State of recruitment

The estimates of absolute recruitment in millions of individuals (age class 1) from VIT analysis were 15.2 in 2006, 8.1 in 2007, 7.1 in 2008, 5.1 in 2009, and 3.9 in 2010. Value estimated in 2009 are not considered reliable.

6.21.8.1.3 State of exploitation

STECF EWG 11-12 proposes $F_{0.1}$= 0.30 (Fmsy proxy) as limit reference point consistent with high long term yields and low risk of fisheries collapse. Since the current fishing mortality is higher than $F_{0.1,}$ the stock of common Pandora in the Northern sector of the Strait of Sicily is assessed being subject to overfishing. Considering the fishing mortality in 2010 (F_{curr}=0.60), to reach the proposed TRP a reduction of Fc of about 50% is advisable. EWG 11-12 recommends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

6.21.8.2 Medium term considerations

Considering the Sicilian fleet operating in GSAs 15-16, for which both commercial data were available at STECF EWG 11-12, a reduction of about 50% of the fishing mortality in 2010 is required to achieve as sustainable exploitation. However stock does not shown sign of decrease of SSB and recruitment indices from trawl surveys.

The working group was informed that the Italian government has adopted a management plan in which a reduction of trawler capacity of 25% is planned by 2013 as compared with 2008. STECF EWG 11-12 recommends to continuously reduce current F through consistent effort reductions, and an improvement in current exploitation patterns.

6.22 Stock assessment of anchovy in GSA 16

6.22.1 Stock identification and biological features

6.22.1.1 Stock Identification

This assessment of the anchovy stock in GSA 16 is mainly based on information collected over the last decade on the fishery grounds off the southern Sicilian coast (GSA 16, South of Sicily), and specifically using biomass estimates obtained by hydro-acoustic surveys and catch/effort data from local small pelagic fisheries. The main distribution area of the anchovy stock in GSA 16 is the narrow continental shelf area between Mazara del Vallo and the southernmost tip of Sicily, Cape Passero (Patti *et al*., 2004). Daily Egg Production Method (DEPM) surveys were also carried out starting from 1998, giving also information on spawning areas distribution.

6.22.1.2 Growth

Growth parameters were only used for the estimation of natural mortality with the approches suggested by Pauly (1980) and the Beverton & Holt's Invariants method (Jensen, 1996). Von-Bertalanffy growth parameters were estimated by FISAT using DCF data collected in GSA16 over the period 2007-2009. The applied growth parameters are given below in the following table:

L_∞	k	t_0
19.83	0.31	-1.95

For BHI method, the equation $M = \beta * k$ was applied, with β set to 1.8.

6.22.1.3 Maturity

Maturity data were not used for this assessment.

6.22.2 Fisheries

6.22.2.1 General description of fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

6.22.2.2 Management regulations applicable in 2010 and 2011

Fisheries practices are affected by EU regulations through the Common Fisheries Policy (CFP), based on the following principles: protection of resources; adjustment of (structure) facilities to the available resources; market organization; and definition of relationships with other countries.

The main technical measures regulating fishing concern minimum landing size (9 cm for anchovy, 11 cm for sardine), mesh regulations (20 mm for pelagic pair trawlers, 14 mm for purse seiners) and restrictions on the use of fishing gear. Towed fishing gears are not allowed in the coastal area in less than 50 m depth, or within a distance of 3 nautical miles from the coastline. A seasonal closure for trawling, generally during summer-autumn, has been established since 1993. In GSA 16, two operational units fishing for small pelagic are based in Sciacca port: purse seiners (lampara vessels, locally known as "Ciancioli") and midwaters pair trawlers ("Volanti a coppia"). Midwaters trawlers are based in Sciacca port only, and receive a special permission from Sicilian Authorities on an annual basis. Another fleet fishing on small pelagic fish species, based in some northern Sicilian ports, was used to target on juvenile stages (mainly sardines). However this fishery, which in the past was allowed for a limited period (usually one or two months in the winter season) by a special Regional law renewed year by year, was no more authorized starting from 2010 and it is presently stopped.

6.22.2.3 Catches

6.22.2.3.1 Landings

Landings were obtained within the framework of the census data collection carried out by IAMC-CNR (Mazara del Vallo) in Sciacca port since 1998. Information collected in the framework of CA.SFO study project (Patti et al., 2007) showed that landings in Sciacca port account for about 2/3 of the total landings in GSA 16. Average anchovy landings in Sciacca port over the period 1998-2010 were about 1,800 metric tons, with large inter-annual fluctuations.

It is worth noting that, though anchovy biomass was decreasing very during the last years (with the only exception of 2010, when the stock experienced a significant increase; see Fig. 6.22.2.3.1.1), landings levels over the same period remained relatively high (Fig. 6.22.2.3.1.1).

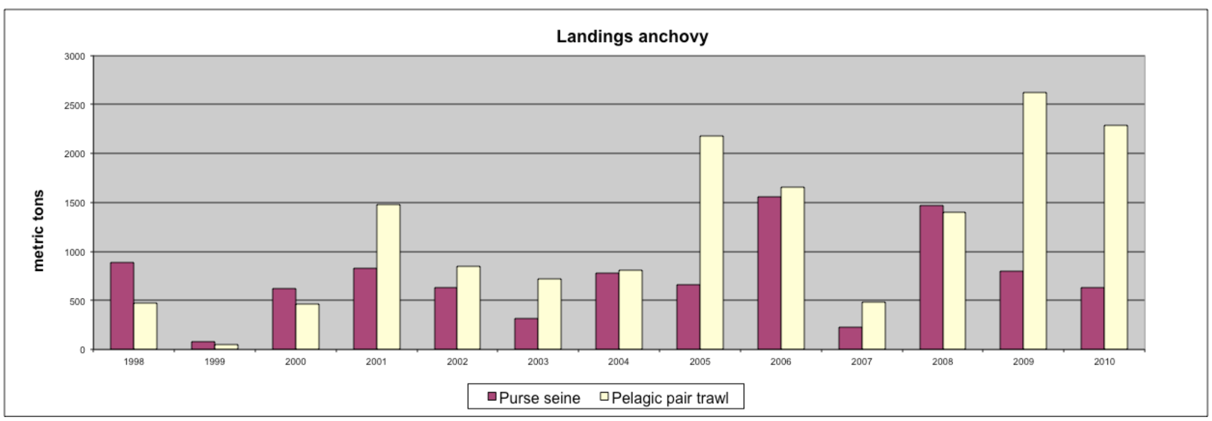


Fig. 6.22.2.3.1.1. Landings data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2010.

6.22.2.3.2 Discards

No discards data for anchovy were used for this assessment. However, discards are estimated to be less than 5% of total catch for both the pelagic pair trawl and the purse seine fisheries (Kallianiotis & Mazzola, 2002).

6.22.2.4 Fishing effort

Fishing effort data refer to census data collected in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16.

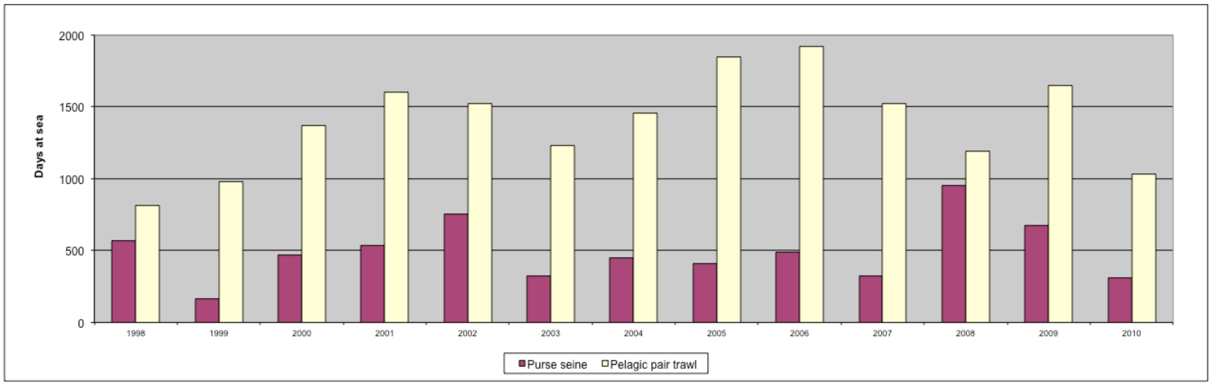


Fig. 6.22.2.4.1. Effort data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2010.

Fishing effort officially reported in 2011 through the DCF is also given below.

Tab. 6.22.2.4.1. Fishing effort (kW*days) as officially reported in 2011 through the DCF.

AREA	COUNTRY	GEAR	2004	2005	2006	2007	2008	2009	2010
SA 16	ITA	-1	510755	166307	326382	322280	244200	19958	162725
SA 16	ITA	FPO		3315	4134	24573		32546	19769
SA 16	ITA	GNS	72911					23354	6919
SA 16	ITA	GTR	2856282	2740397	2061147	2238474	1817880	2332119	1895364
SA 16	ITA	LLD	2445223	1126930	1190370	1986039	968632	1022321	1032262
SA 16	ITA	LLS	791587	788804	701737	729876	469933	592043	430656
SA 16	ITA	LTL		1188	3132				
SA 16	ITA	OTB	22019100	24560236	23812187	23046380	19534052	20447594	20412436
SA 16	ITA	OTM	71350	153833	309326		411995	421505	356224
SA 16	ITA	PS	1069415	848533	1290163	1394781	1533138	883222	616488
SA 16	ITA	PTB		264153	756502	887812	528969	485308	334649

6.22.3 Scientific surveys

6.22.3.1 Acoustics

6.22.3.1.1 Methods

Acoustic surveys methodology

Steps for biomass estimation

- Collection of acoustic and biological data during surveys at sea;

- Extraction of $NASC_{Fish}$ (Fishes Nautical Area Scattering Coefficient [$m^2/n.mi^2$]) by means of Echoview (Sonar Data) post-processing software;
- Link of NASC values to control catches;
- Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data;
- Production of ρ distribution maps for different fish species and size classes;
- Integration of density areas for biomass estimation.

Collection of acoustic and biological data

Since 1998 the IAMC-CNR has been collecting acoustic data for evaluating abundance and distribution pattern of small pelagic fish species (mainly anchovy and sardine) in the Strait of Sicily (GSA 16). The scientific echosounder Kongsberg Simrad EK500 was used for acquiring acoustic data until summer 2005; for the echosurvey in the period 2006-2010 the EK60 echosounder was used. In both cases the echosounder was equipped with three split beam transducers pulsing at 38, 120 and 200 kHz. During the period 1998-2008 acoustic data were collected continuously during day and night time; since the 2009 echosurvey acoustic data are collected during day time, according to the MEDIAS protocol.

Before or after acoustic data collection a standard procedure for calibrating the three transducers was carried out by adopting the standard sphere method (Johannesson & Mitson, 1983).

Biological data were collected by a pelagic trawl net with the following characteristics: total length 78 m, horizontal mouth opening 13-15 m, vertical mouth opening 6-8 m, mesh size in the cod-end 10 mm. The net was equipped with two doors with weight 340 kg. During each trawl the monitoring system SIMRAD ITI equipped with trawl-eye and temp-depth sensors was adopted.

Extraction of $NASC_{Fish}$ by means of Echoview (Sonar Data) post-processing software

The evaluation of the $NASC_{Fish}$ (Fishes Nautical Area Scattering Coeffcient [$m^2/n.mi^2$]) and the total NASC for each nautical mile of the survey track was performed by means of the SonarData Echoview software v3.50, taking into account the day and night collection periods.

Link of NASC values to control catches

For the echo trace classification the nearest haul method was applied, taking into account only representative fishing stations along transects.

Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data

For each trawl haul the frequency distribution of the j-th species (ν_j) and for the k-th length class (f_{jk}) are estimated as $$\nu_j = \frac{n_j}{N} \quad \text{and} \quad f_{jk} = \frac{n_{jk}}{n_j}$$

where n_j is the total number of specimens of the j-th species, n_{jk} is the total number of specimens of the k-th length class in the j-th species, and N is the total number of specimens in the sample.

For each nautical mile the densities for each size class and for each fish species are estimated as

$$\rho_{jk} = \frac{NASC_{FISH} * n_{jk}}{\sum_{j=1}^{n}\sum_{k=1}^{m} n_{jk} * \sigma_{jk}} \qquad \text{(number of fishes / n.mi}^2\text{)}$$

$$\rho_{jk} = \frac{NASC_{FISH} * W_{jk} * 10^{-6}}{\sum_{j=1}^{n}\sum_{k=1}^{m} n_{jk} * \sigma_{jk}} \qquad \text{(t / n.mi}^2\text{)}$$

where W_{jk} is the total weight of the *k*-th length class in the *j*-th species, and σ_{jk} is the scattering cross section of the *k*-th length class in the *j*-th species. σ_{jk} is given by

$$\sigma_{spjk} = 4\pi * 10^{\frac{TS_{jk}}{10}}$$

where the target strenght (TS) is

$$TS_{jk} = a_j Log_{10}(L_k) + b_j$$

L_k is the length of the *k*-th length class while the a_j and b_j coefficient are linked to the fish species.

For anchovy, sardine and trachurus we adopted respectively the following relationships:

$TS = 20 \log L_k 76.1$ [*dB*]

$TS = 20 \log L_k 70.51$ [*dB*]

$TS = 20 \log L_k 72$ [*dB*]

Integration of density areas for biomass estimation

The abundance of each species was estimated by integrating the density surfaces for each species.

6.22.3.1.2 Geographical distribution patterns

No analyses were conducted during EWG 11-12.

6.22.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the anchovy stock in GSA 16 was derived from the acoustics. Figure 6.22.3.1.3.1 displays the estimated trend in anchovy total biomass (estimated by acoustics) for GSA 16. A decreasing trend was observed in biomass during the last years (Fig. 6.22.3.1.3.1). After a series of four consecutive very low values over the period 2006-2009, the stock appeared to partially recover in 2010, when estimated biomass was higher than the average value over the entire time series (about 16,000 t vs. 13,000 t).

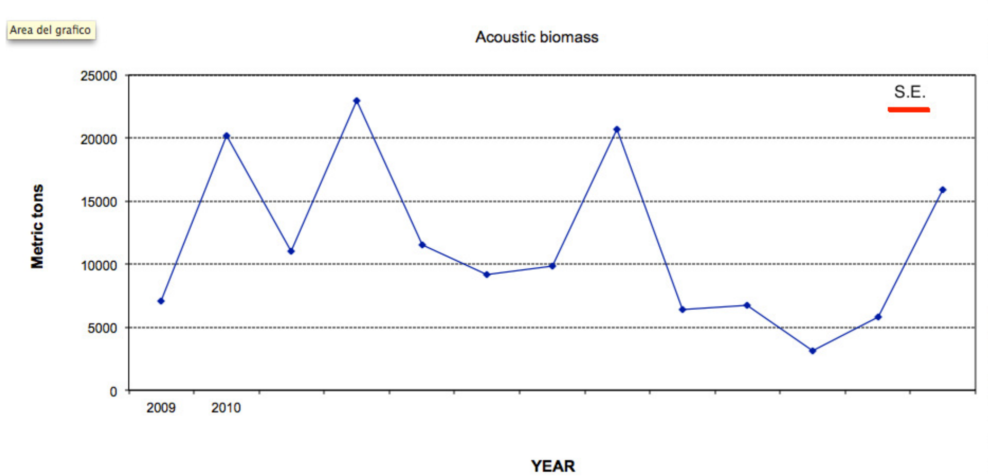


Fig. 6.22.3.1.3.1. Estimated anchovy biomass indices for GSA 16, years 1998-2009. Standard error for 2010 survey is also given (red line).

6.22.3.1.4 Trends in abundance by length or age

Length or age class data were not used for this assessment.

6.22.3.1.5 Trends in growth

Not applicable. Growth data were only used for the estimation of natural mortality with the approches suggested by Pauly (1980) and the Beverton & Holt's Invariants method (Jensen, 1996).

6.22.3.1.6 Trends in maturity

Maturity data were not used for this assessment.

6.22.4 Assessment of historic stock parameters

For the analysis of data, the medium-term aim is to apply age-based analytical assessment methods to the stock, such as VPA-based methods like ICA, XSA, or others. However, to use such methods catch statistics have to be age-disaggregated, in order to follow the different year-classes age by age and year by year through the time series of catch data. Age-disaggregated data for anchovy stock in GSA16 are available, but have not been yet properly arranged to be used as input data for any specific age-based assessment method. Therefore, a surplus production modelling approach, not requiring age-disaggregated catch data, has been adopted for the current assessment.

6.22.4.1 Method: Surplus production modelling

6.22.4.1.1 Justification

The achovy stock in the area was assessed using a non-equilibrium surplus production model based on the Schaefer (logistic) population growth model.

The model was implemented in an MS Excel spreadsheet, modified from the spreadsheets distributed by FAO under the BioDyn package (P. Barros, pers. comm.). Details about the implementation of the applied logistic modelling approach can be found in a FAO report on the Assessment of Small Pelagic Fish off Northwest Africa (FAO, 2004).

The report is available at the web site http://www.fao.org/docrep/007/y5823b/y5823b00.htm.

The model uses four basic parameters: Carring capacity (or Virgin Biomass) K, population intrinsic growth rate r, initial depletion BI/K (starting biomass relative to K) and catchability q. Given the best parameter estimates, the model calculates the MSY, B_{MSY} and F_{MSY} reference points.

Derived reference points B_{Cur}/B_{MSY} (ratio indicating whether the estimated stock biomass, in any given year, is above or below the biomass producing the MSY), and F_{Cur}/FSY_{Cur} (the ratio between the fishing effort in the last year of the data series and the effort that would have produced the sustainable yield at the biomass levels estimated in the same year, indicating whether the estimated fishing mortality coefficient, in any given year, is above or below the fishing mortality coefficient producing the sustainable yield in that year) were also evaluated. Values of F_{Cur}/FSY_{Cur} below 100% indicate that the current catch is lower than the natural production of the stock, and thus that the stock biomass is expected to increase in the following year, while values above 100% indicate a situation where fishing mortality exceeds the stock natural production, and thus the stock biomass will decline next year. For comparison purposes, also the series of F_{Cur}/F_{MSY} was evaluated and reported.

6.22.4.1.2 Input parameters

The fitting of the model was based on fitting the series of observed abundance indices, assuming an observation error model. The model implementation adopted allows for the optional incorporation of environmental indices, so that the *r* and *K* parameters of each year are considered to depend on the corresponding value of the applied index. The objective function, minimised with a non-linear algorithm implemented with the Solver add-in in MS Excel, was the sum of the squared residuals between the logarithms of the observed and predicted indices.

The input data used for the stock was total yearly catch estimates, and a series of abundance indices. Specifically, the time series of estimated total yearly anchovy landings for GSA 16 between 1998 and 2010 was used as input data for the model, together with the abundance indices from acoustic surveys from the same set of years. The scientific surveys, mainly carried during early summer of each year, were considered to represented the stock abundance the same year. In addition an enviromental index, the satellite based estimate of yearly average chlorophyll-a concentration over the continental shelf off the southern sicilian coast, was used in the attempt of improving the performance of the model fitting, since pelagic stocks are known to be significantly affected by environmental variability.

6.22.4.1.3 Results

Using the Excel spreadsheet, several model control settings have been tested. The first run was carried out without the incorporation of the selected environmental index. With this configuration, the best obtained fit was very poor (R^2=0.04; see Fig. 6.22.4.1.3.1). It appears that the evolution of the stock biomass cannot be explained solely by the dynamic of the catches or the average stock growth conditions, i.e. the model with constant parameters is not adequate to account for the high fluctuactions in the time series. Current knowledge suggests that observed changes could be linked to strong environmental forcings (Basilone et al., 2004; Basilone et al., 2006; Patti et al., 2010). Therefore, a modification of the model was made to include environmental variability (average yearly chlorophyll concentration).

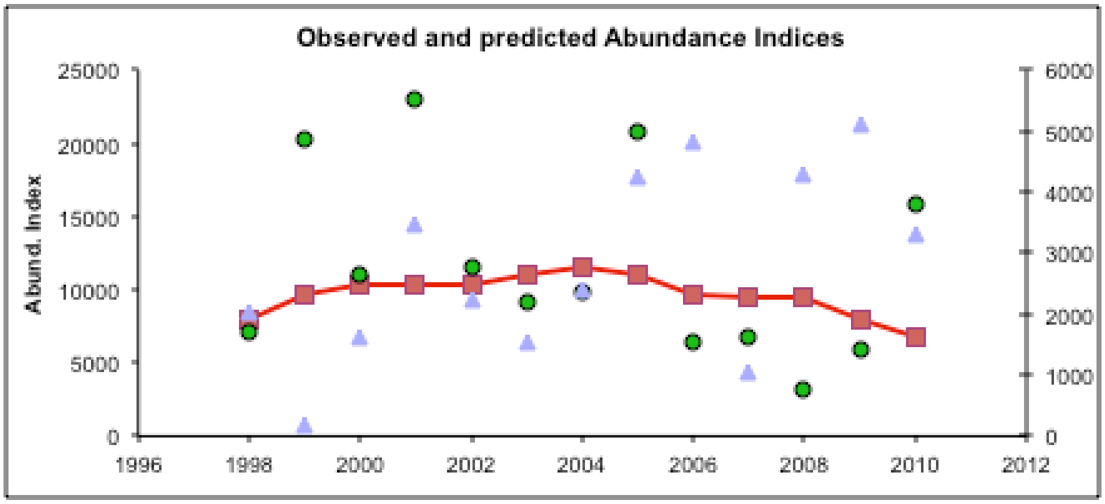


Fig. 6.22.4.1.3.1. Observed (green circles) and predicted sardine biomass, model with constant *K* and *r* parameters. Catches (purple triangles) are indicated on the right axis.

Fig. 6.22.4.1.3.2 shows the trends in observed and predicted anchovy biomass, model incorporating an environmental index. The best fit, obtained including an exponential environmental effect in the population intrinsic growth rate (r), explained the 48% of total variance.

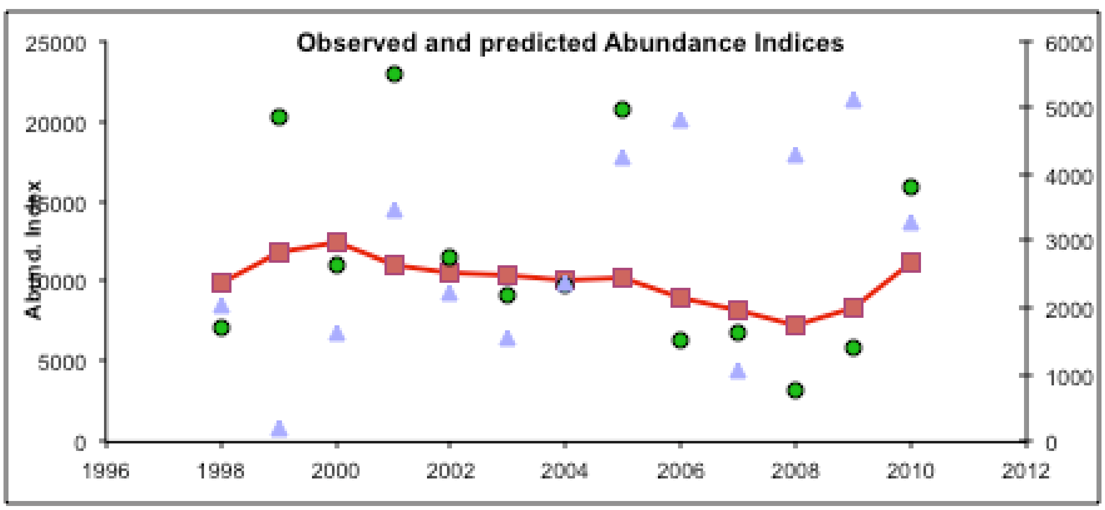


Fig. 6.22.4.1.3.2. Observed (green circles) and predicted anchovy biomass, model with constant *K* and variable *r*. Catches (purple triangles) are indicated on the right axis.

Trends in B_{CUR}/B_{MSY} indicate that stock biomass was below the reference limit throughout the entire length of the time series (Fig. 6.22.4.1.3.3).

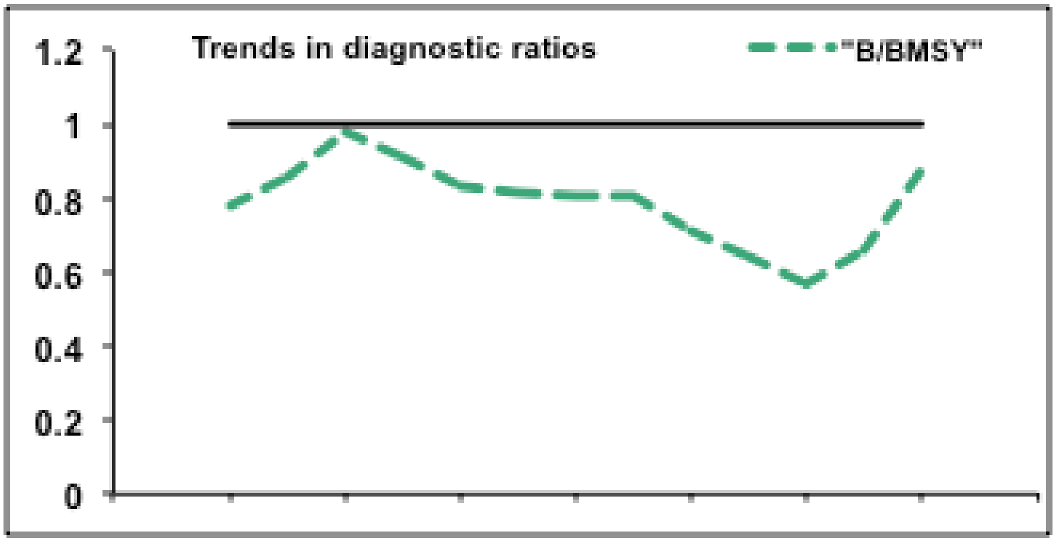


Fig. 6.22.4.1.3.3. Trends in B_i/B_{MSY} over the period 1998-2010.

Current fishing mortality is below the sustainable fishing mortality at current biomass levels (Fig. 6.22.4.1.3.1), but fishing mortality experienced very high fluctuations during the considered period (Fig. 6.22.4.1.3.4). Finally, current sustainable production is about the 73% of the MSY (Fig. 6.22.4.1.3.5).

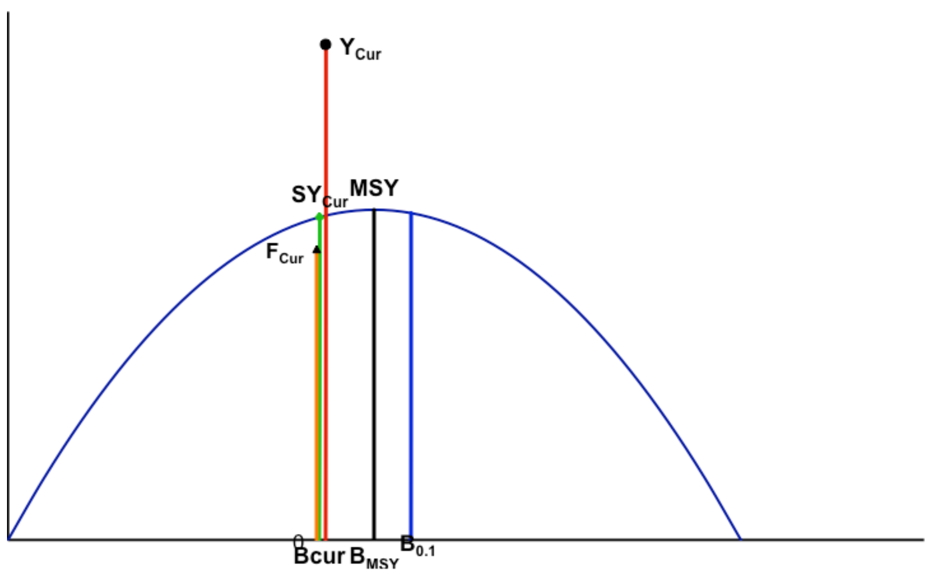


Fig. 6.22.4.1.3.4. Current situation of the anchovy stock.

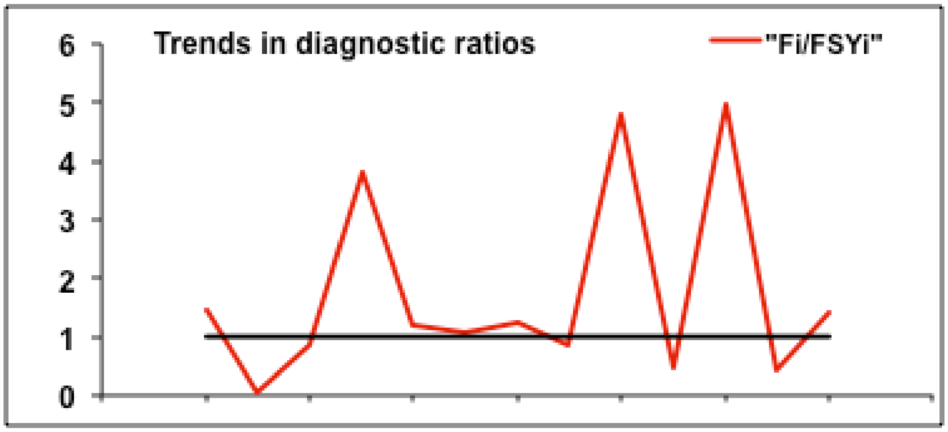


Fig. 6.22.4.1.3.5. Trends in F_i/FSY_i over the period 1998-2010.

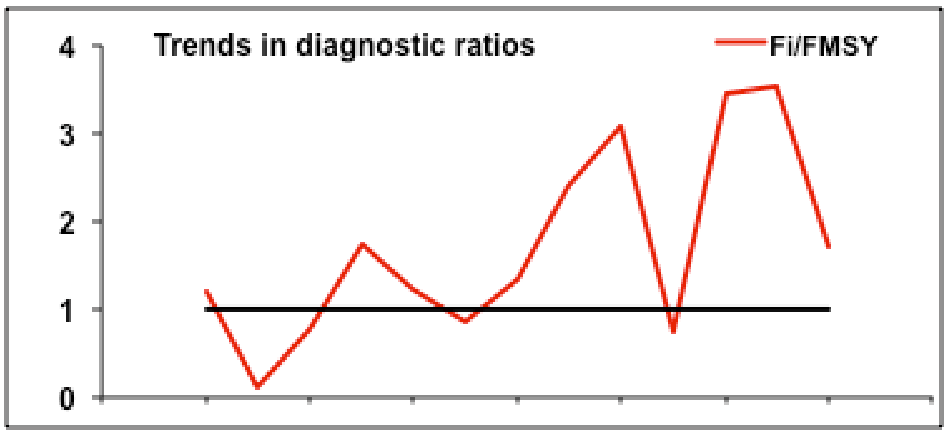


Fig. 6.22.4.1.3.6. Trends in F_i/F_{MSY} over the period 1998-2010.

Current fishing mortality is far above the sustainable fishing mortality at current biomass levels_(Table 6.22.4.1.3.1). Fishing mortality experienced very high values during the considered period, frequently well above the reference limit (Fig. 6.22.4.1.3.3). In addition B/B_{MSY} values was below 100% over the entire time series decade, indicating the stock has historically been overfished.

Table 6.22.4.1.3.1. Reference points. Current estimates refer to year 2010.

MSY	B_{MSY}	F_{MSY}	B_{Cur}/B_{MSY}	F_{Cur}/FSY_{Cur}	F_{Cur}/F_{MSY}
2198	17584	0.13	0.85	1.53	1.76

Actually, given the high sensitivity of this species to changes in environmental conditions, and the instability of the environment on the continental shelf of GSA16 (the habitat for the stock), characterized by coastal wind-induced upwelling and high short term mesoscale variability, it is expected that the anchovy stock may experience periods of very different productivity.

6.22.5 Short term prediction

Analysis has not been done during STECF EWG 11-12.

6.22.6 *Long term prediction*

Not applicable. No forecast analyses were conducted.

6.22.7 *Scientific advice*

6.22.7.1 Short term considerations

6.22.7.1.1 State of the spawning stock size

Biomass estimates of total population obtained by hydro-acoustic surveys for anchovy in GSA 16 show a decreasing trend over the last decade, despite the occurrence of quite large inter-annual fluctuations, from a maximum of about 22,900 t in 2001 to a minimum of 3,100 t in 2008. Biomass estimates over the period 2006-2009 surveys were the lowest of the series (their average representing less than one-quarter of the maximum recorded value). However, anchovy stock biomass experienced a significant increase in 2010. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

STECF EWG 11-12 notes that no age-structured production model was used at this stage. However, a logistic (Shaefer) non-equilibrium general production modeling approach was adopted for the evaluation of stock status.

6.22.7.1.2 State of recruitment

No recruitment data were provided by this assessment.

6.22.7.1.3 State of exploitation

EWG 11-12 recommends E=0.4 as limit management reference point consistent with high long term yields. The high and increasing yearly harvest rates, as estimated by the ratio between total landings and stock sizes, might indicate high fishing mortality levels. The current (2010) harvest rate is 0.28, whereas the estimated average value over the years 2007-2010 is 0.67. The exploitation rate corresponding to F=0.67 is E=0.50, if M=0.66, estimated with Pauly (1980) empirical equation, is assumed, and E=0.54 if M=0.56, estimated with Beverton & Holt’s Invariants method (Jensen, 1996), is used instead. Using the exploitation rate as a reference point, this stock should be considered as being subject to overfishing.

Based on the implementation of a logistic surplus production model the fluctuations in stock biomass cannot be explained solely by the observed fishing pattern. This was an expected result, as pelagic stocks are known to be significantly affected by environmental variability. The incorporation of an environmental index in the model significantly improved the fitting of the model, allowing the stock to grow more or less than average depending on the state of the environment in each year. In the current formulation satellite-based data on chlorophyll concentration showed to have a positive effect on the yearly population intrinsic growth rate.

Management recommendations

Results of the adopted modelling approach suggest that the environmental factors can be very important in explaining the variability in yearly biomass levels (mostly based on recruitment success) and indicate that the stock status was below the B_{MSY} during the considered period. Though in 2010 the stock biomass increased significantly from the low biomass levels experienced during the period 2006-2009, the stock biomass is currently lower than B_{MSY}, and in addition fishing levels are higher than F_{msy}.

Based on available information and assuming status quo exploitation in 2010, EWG 11-12 recommends the relevant fleet effort should not be allowed to increase in order to avoid future loss in stock productivity and landings. EWG notes that mere effort management of fisheries targeting stocks of small pelagics implies a high risk due to their schooling behavior and the multi-species character of their fisheries (changing target species as available and appropriate). EWG 11-12 rather recommends the consideration of landing restrictions as a more effective management tool for small pelagics. EWG 11-12 recommends a multi-annual management plan being implemented taking into account mixed-fisheries effects, in particular the technical relation with sardine fisheries.

6.23 Stock assessment of sardine in GSA 16

6.23.1 Stock identification and biological features

6.23.1.1 Stock Identification

The assessment of the sardine stock in GSA 16 is mainly based on information collected over the last decade on fishery grounds off the southern Sicilian coast (GSA 16, South of Sicily), and specifically on biomass estimates obtained by hydroacoustic surveys and catch-effort data from local small pelagic fisheries. The main distribution area of the sardine stock in GSA 16 is the narrow continental shelf area between Mazara del Vallo and the southernmost tip of Sicily, Cape Passero (Patti *et al.*, 2004).

6.23.1.2 Growth

Growth parameters were only used for the estimation of natural mortality with the approches suggested by Pauly (1980) and the Beverton & Holt's Invariants method (Jensen, 1996). Von-Bertalanffy growth parameters were estimated by FISAT using DCF data collected in GSA16 over the period 2007-2008. The applied growth parameters are given below in the following table:

L_∞	k	t_0
21.41	0.40	-1.83

For BHI method, the equation $M = \beta * k$ was applied, with β set to 1.8.

6.23.1.3 Maturity

Maturity data were not used for this assessment.

6.23.2 Fisheries

6.23.2.1 General description of fisheries

In Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16, two operational units (OU) are presently active, purse seiners and pelagic pair trawlers. The fleet in GSA 16 is composed by about 50 units (17 purse seiners and 30 pelagic pair trawlers were counted up in a census carried out in December 2006). In both OUs, anchovy represents the main target species due to the higher market price.

6.23.2.2 Management regulations applicable in 2010 and 2011

Fisheries practices are affected by EU regulations through the Common Fisheries Policy (CFP), based on the following principles: protection of resources; adjustment of (structure) facilities to the available resources; market organization and definition of relationships with other countries.

The main technical measures regulating fishing concern minimum landing size (9 cm for anchovy, 11 cm for sardine), mesh regulations (20 mm for pelagic pair trawlers, 14 mm for purse seiners) and restrictions on the use of fishing gear. Towed fishing gears are not allowed in the coastal area in less than 50 m depth, or within a distance of 3 nautical miles from the coastline. A seasonal closure for trawling, generally during summer-autumn, has been established since 1993. In GSA 16, the two operational units fishing for small pelagic are present, mainly based in Sciacca port: purse seiners (lampara vessels, locally known as “Ciancioli”) and midwaters pair trawlers (“Volanti a coppia”). Midwaters trawlers are based in Sciacca port only, and receive a special permission from Sicilian Authorities on an annual basis. Another fleet fishing on small pelagic fish species, based in some northern Sicilian ports, was used to target on juvenile stages (mainly sardines). However this fishery, which in the past was allowed for a limited period (usually one or two months in the winter season) by a special Regional law renewed year by year, was no more authorized starting from 2010 and it is presently stopped.

6.23.2.3 Catches

6.23.2.3.1 Landings

Landings were obtained within the framework of the census data collection carried out by IAMC-CNR (Mazara del Vallo) in Sciacca port since 1998. Information collected in the framework of CA.SFO study project (Patti *et al*., 2007) showed that landings in Sciacca port account for about 2/3 of the total landings in GSA 16. Average sardine landings in Sciacca port over the period 1998-2010 were about 1,400 metric tons, with a general decreasing trend especially in 2010 (-70%).

It is worth noting that, though trend in biomass is clearly decreasing over the last years (Fig. 6.23.2.1.3.1), landings levels over the same period were relatively high (Fig. 6.23.2.1.3.1).

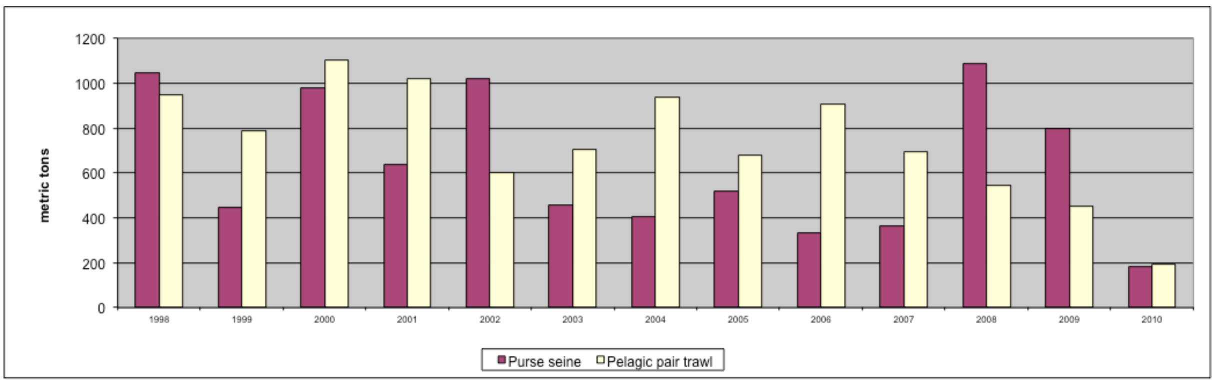


Fig. 6.23.2.1.3.1. Landings data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2010.

Tab. 6.23.2.1.3.1. Landings (t) as officially reported in 2011 through the DCF.

SPECIES	AREA	COUNTRY	FT_LVL4	FT_LVL5	2004	2005	2006	2007	2008	2009	2010
PIL	16	ITA	OTB	DEMSP	1		0	1	3	7	5
PIL	16	ITA	OTB	MDDWSP		14	9	4		0	
PIL	16	ITA	PS	LPF	18		174				
PIL	16	ITA	PS	SPF	872	904	1543	1559	1622	1301	584
PIL	16	ITA	PTM	SPF		332	500	610	442	342	183

6.23.2.3.2 Discards

No discards data for sardine were used for this assessment. However, discards are estimated to be less than 5% of total catch for both the pelagic pair trawl and the purse seine fisheries (Kallianiotis & Mazzola, 2002).

6.23.2.4 Fishing effort

Fishing effort data refer to census data collected in Sciacca port, the most important base port for the landings of small pelagic fish species along the southern Sicilian coast (GSA 16), accounting for about 2/3 of total landings in GSA 16.

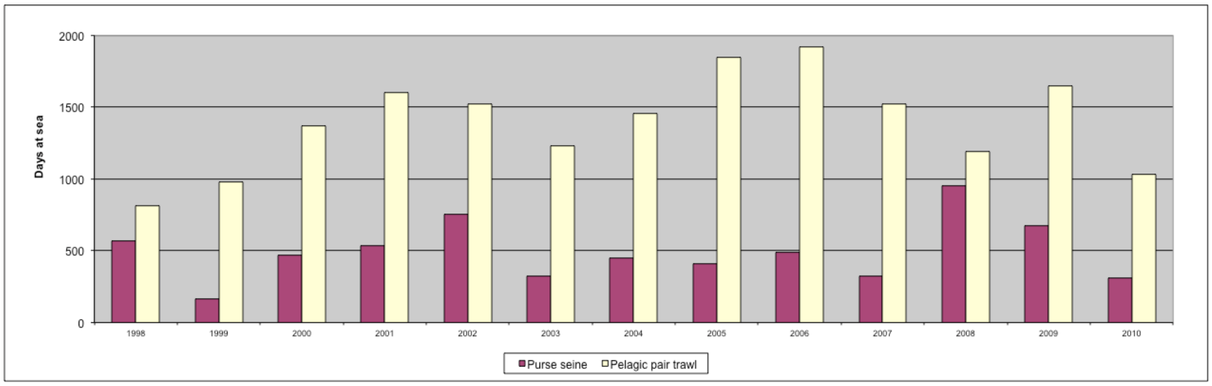


Fig. 6.23.2.4.1. Effort data regarding the purse seine and pelagic pair trawl fleets in Sciacca port (GSA 16), 1998-2010.

Fishing effort officially reported in 2011 through the DCF is also given below.

Tab. 6.23.2.4.1. Fishing effort (kW*days) as officially reported in 2011 through the DCF.

AREA	COUNTRY	GEAR	2004	2005	2006	2007	2008	2009	2010
SA 16	ITA	-1	510755	166307	326382	322280	244200	19958	162725
SA 16	ITA	FPO		3315	4134	24573		32546	19769
SA 16	ITA	GNS	72911					23354	6919
SA 16	ITA	GTR	2856282	2740397	2061147	2238474	1817880	2332119	1895364
SA 16	ITA	LLD	2445223	1126930	1190370	1986039	968632	1022321	1032262
SA 16	ITA	LLS	791587	788804	701737	729876	469933	592043	430656
SA 16	ITA	LTL		1188	3132				
SA 16	ITA	OTB	22019100	24560236	23812187	23046380	19534052	20447594	20412436
SA 16	ITA	OTM	71350	153833	309326		411995	421505	356224
SA 16	ITA	PS	1069415	848533	1290163	1394781	1533138	883222	616488
SA 16	ITA	PTB		264153	756502	887812	528969	485308	334649

6.23.3 Scientific surveys

6.23.3.1 Acoustics

6.23.3.1.1 Methods

Acoustic surveys methodology

Steps for biomass estimation

- Collection of acoustic and biological data during surveys at sea;
- Extraction of $NASC_{Fish}$ (Fishes Nautical Area Scattering Coefficient [$m^2/n.mi^2$]) by means of Echoview (Sonar Data) post-processing software;
- Link of NASC values to control catches;
- Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data;
- Production of ρ distribution maps for different fish species and size classes;
- Integration of density areas for biomass estimation.

Collection of acoustic and biological data

Since 1998 the IAMC-CNR has been collecting acoustic data for evaluating abundance and distribution pattern of small pelagic fish species (mainly anchovy and sardine) in the Strait of Sicily (GSA 16). The scientific echosounder Kongsberg Simrad EK500 was used for acquiring acoustic data until summer 2005; for the echosurvey in the period 2006-2010 the EK60 echosounder was used. In both cases the echosounder was equipped with three split beam transducers pulsing at 38, 120 and 200 kHz. During the period 1998-2008 acoustic data were collected continuously during day and night time; since the 2009 echosurvey acoustic data are collected during daytime, according to the MEDIAS protocol.

Before or after acoustic data collection a standard procedure for calibrating the three transducers was carried out by adopting the standard sphere method (Johannesson & Mitson, 1983).

Biological data were collected by a pelagic trawl net with the following characteristics: total length 78 m, horizontal mouth opening 13-15 m, vertical mouth opening 6-8 m, mesh size in the cod-end 10 mm. The net was equipped with two doors with weight 340 kg. During each trawl the monitoring system SIMRAD ITI equipped with trawl-eye and temp-depth sensors was adopted.

Extraction of $NASC_{Fish}$ by means of Echoview (Sonar Data) post-processing software

The evaluation of the $NASC_{Fish}$ (Fishes Nautical Area Scattering Coeffcient [$m^2/n.mi^2$]) and the total NASC for each nautical mile of the survey track was performed by means of the SonarData Echoview software v3.50, taking into account the day and night collection periods.

Link of NASC values to control catches

For the echo trace classification the nearest haul method was applied, taking into account only representative fishing stations along transects.

Calculation of Fish density (ρ) from $NASC_{Fish}$ values and biological data

For each trawl haul the frequency distribution of the j-th species (ν_j) and for the k-th length class (f_{jk}) are estimated as $\nu_j = \frac{n_j}{N}$ and $f_{jk} = \frac{n_{jk}}{n_j}$

where n_j is the total number of specimens of the j-th species, n_{jk} is the total number of specimens of the k-th length class in the j-th species, and N is the total number of specimens in the sample.

For each nautical mile the densities for each size class and for each fish species are estimated as

$$\rho_{jk} = \frac{NASC_{FISH} * n_{jk}}{\sum_{j=1}^{n}\sum_{k=1}^{m} n_{jk} * \sigma_{jk}} \qquad \text{(number of fishes / n.mi}^2\text{)}$$

$$\rho_{jk} = \frac{NASC_{FISH} * W_{jk} * 10^{-6}}{\sum_{j=1}^{n}\sum_{k=1}^{m} n_{jk} * \sigma_{jk}} \qquad \text{(t / n.mi}^2\text{)}$$

where W_{jk} is the total weight of the k-th length class in the j-th species, and σ_{jk} is the scattering cross section of the k-th length class in the j-th species. σ_{jk} *is given by*

$$\sigma_{spjk} = 4\pi * 10^{\frac{TS_{jk}}{10}}$$

where the target strenght (TS) is

$$TS_{jk} = a_j Log_{10}(L_k) + b_j$$

L_k is the length of the k-th length class while the a_j and b_j coefficient are linked to the fish species.

For anchovy, sardine and trachurus we adopted respectively the following relationships:

$TS = 20 \log L_k \; 76.1$ [dB]
$TS = 20 \log L_k \; 70.51$ [dB]
$TS = 20 \log L_k \; 72$ [dB]

Integration of density areas for biomass estimation

The abundance of each species was estimated by integrating the density surfaces for each species.

6.23.3.1.2 Geographical distribution patterns

No analyses were conducted during EWG 11-12.

6.23.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the sardine stock in GSA 16 was derived from the acoustics. Figure 6.23.3.1.3.1 displays the estimated trend in sardine total biomass (estimated by acoustics) for GSA 16.

Values of the last five years are below the general average value over the period 1998-2010 (about 18,000 t).

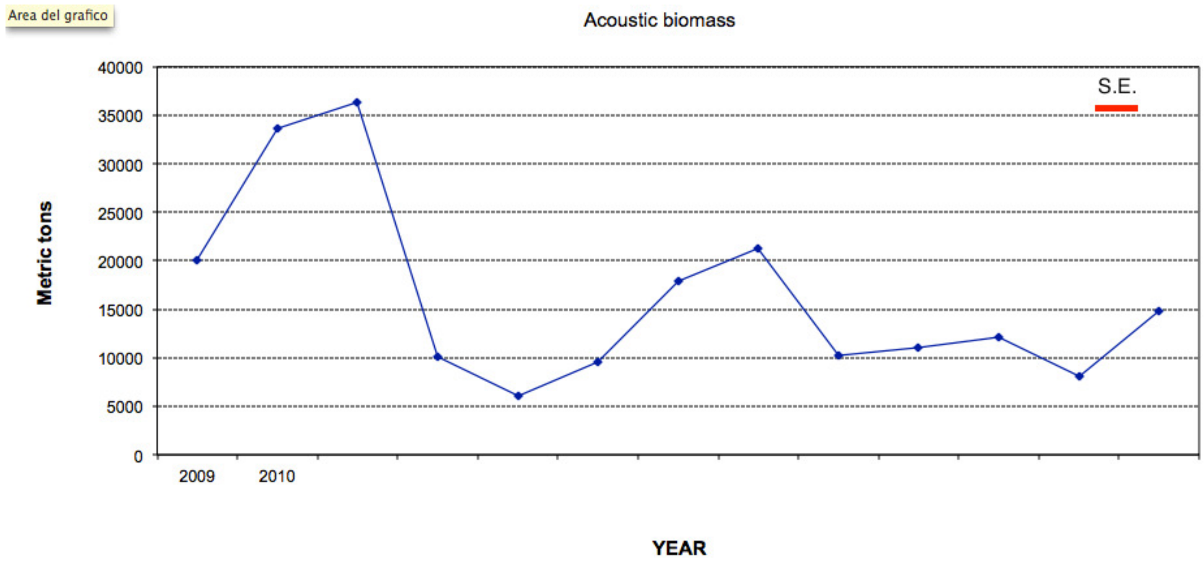


Fig. 6.23.3.1.3.1. Estimated sardine biomass indices for GSA 16, years 1998-2010. Standard error for 2010 survey is also given (red line).

6.23.3.1.4 Trends in abundance by length or age

Length or age class data were not used for this assessment.

6.23.3.1.5 Trends in growth

Not applicable. Growth data were only used for the estimation of natural mortality with the approches suggested by Pauly (1980) and the Beverton & Holt's Invariants method (Jensen, 1996).

6.23.3.1.6 Trends in maturity

Maturity data were not used for this assessment.

6.23.4 Assessment of historic stock parameters

For the analysis of data, the medium-term aim is to apply age-based analytical assessment methods to the stock, such as VPA-based methods like ICA, XSA, or others. However, to use such methods catch statistics have to be age-disaggregated, in order to follow the different year-classes age by age and year by year through the time series of catch data. Age-disaggregated data for sardine stock in GSA16 are available, but have not been yet properly arranged to be used as input data for any specific age-based assessment method. Therefore, a surplus production modelling approach, not requiring age-disaggregated catch data, has been adopted for the current assessment.

6.23.4.1 Method 1: Surplus production modelling

6.23.4.1.1 Justification

The sardine stock in the area was assessed using a non-equilibrium surplus production model based on the Schaefer (logistic) population growth model.

The model was implemented in an MS Excel spreadsheet, modified from the spreadsheets distributed by FAO under the BioDyn package (P. Barros, pers. comm.). Details about the implementation of the applied logistic modelling approach can be found in a FAO report on the Assessment of Small Pelagic Fish off Northwest Africa (FAO, 2004).

The report is available at the web site http://www.fao.org/docrep/007/y5823b/y5823b00.htm.

The model uses four basic parameters: Carring capacity (or Virgin Biomass) K, population intrinsic growth rate r, initial depletion BI/K (starting biomass relative to K) and catchability q. Given the best parameter estimates, the model calculates the MSY, B_{MSY} and F_{MSY} reference points.

Derived reference points B_{Cur}/B_{MSY} (ratio indicating whether the estimated stock biomass, in any given year, is above or below the biomass producing the MSY), and F_{Cur}/FSY_{Cur} (the ratio between the fishing effort in the last year of the data series and the effort that would have produced the sustainable yield at the Biomass levels estimated in the same year, indicating whether the estimated fishing mortality coefficient, in any given year, is above or below the fishing mortality coefficient producing the sustainable yield in that year) were also evaluated. Values of F_{Cur}/FSY_{Cur} below 100% indicate that the current catch is lower than the natural production of the stock, and thus that the stock biomass is expected to increase the following year, while values above 100% indicate a situation where fishing mortality exceeds the stock natural production, and thus the stock biomass will decline next year. For comparison purposes, also the series of F_{Cur}/F_{MSY} was evaluated and reported.

The fitting of the model was based on fitting the series of observed abundance indices. The model implementation adopted allows for the optional incorporation of environmental indices, so that the *r* and *K* parameters of each year can be considered to depend on the corresponding value of the applied index. The objective function, minimised with a non-linear algorithm implemented with the Solver add-in in MS Excel, was the sum of the squared residuals between the logarithms of the observed and predicted indices.

6.23.4.1.2 Input parameters

The input data used for the stock was total yearly catch estimates, and a series of abundance indices. Specifically, the time series of estimated total yearly sardine landings for GSA 16 between 1998 and 2010 was used as input data for the model, together with the abundance indices from the acoustic surveys from the same set of years. The scientific surveys, mainly carried during early summer of each year, were considered to represented the stock abundance the same year including part of he recruitment. In addition an enviromental index, the satellite based estimate of yearly average chlorophyll-a concentration over the continental shelf off the southern sicilian coast, was used in the attempt of improving the performance of the model fitting, as expected because pelagic stocks are known to be significantly affected by environmental variability.

6.23.4.1.1 Results

Using the Excel spreadsheet, several model control settings have been tested. The first run was carried out without the incorporation of the selected environmental index. With this configuration, the best obtained fit was quite poor (R^2=0.35; see Fig. 6.23.4.1.1.1). It appears that the evolution of the stock biomass cannot be explained solely by the dynamic of the catches or the average stock growth conditions, i.e. the model with constant parameters is not adequate to account for the high fluctuactions in the time series. Current knowledge suggests that observed changes could be linked to strong environmental forcings (Patti et al., 2010). Therefore, a modification of the model was made to include environmental variability (average yearly chlorophyll concentration).

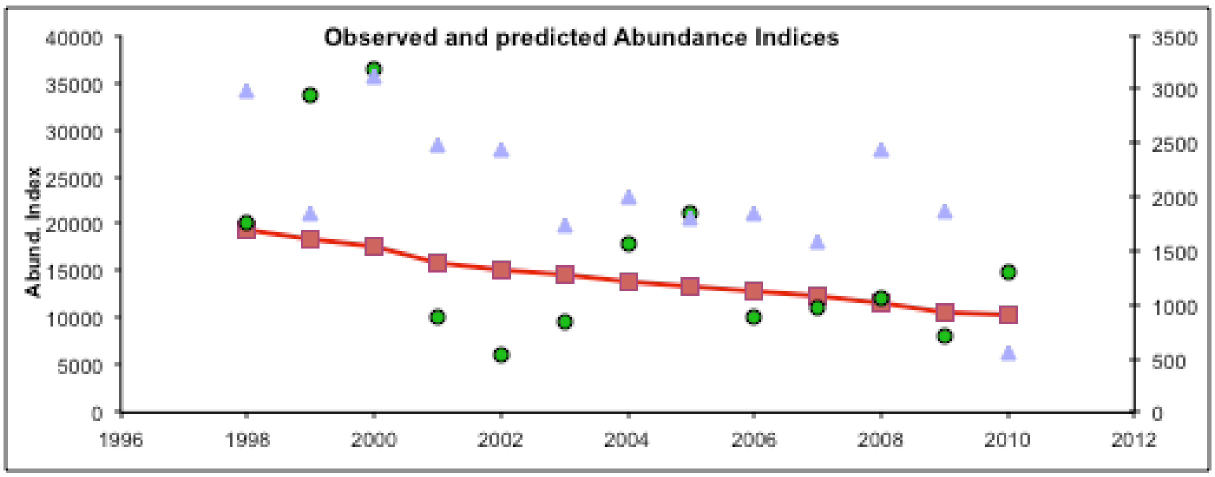


Fig. 6.23.4.1.1.1 Observed (green circles) and predicted sardine biomass, model with constant *K* and *r* parameters. Catches (purple triangles) are indicated on the right axis.

Fig. 6.23.4.1.1.2 shows the trends in observed and predicted sardine biomass, model incorporating an environmental index. The best fit, obtained including an exponential environmental effect in the carrying capacity (K), explained the 76% of total variance.

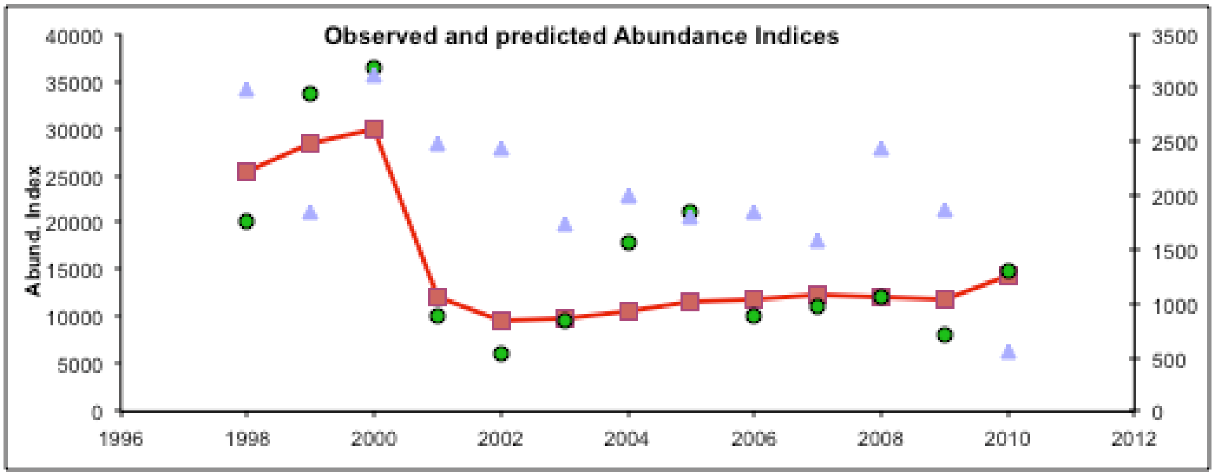


Fig. 6.23.4.1.1.2. Observed (green circles) and predicted sardine biomass, model with variable *K* and constant *r*. Catches (purple triangles) are indicated on the right axis.

Trends in B_{CUR}/B_{MSY} indicate that starting from 2002 stock biomass was below half of the biomass producing the maximum sustainable yield (Fig. Fig. 6.23.4.1.1.3).

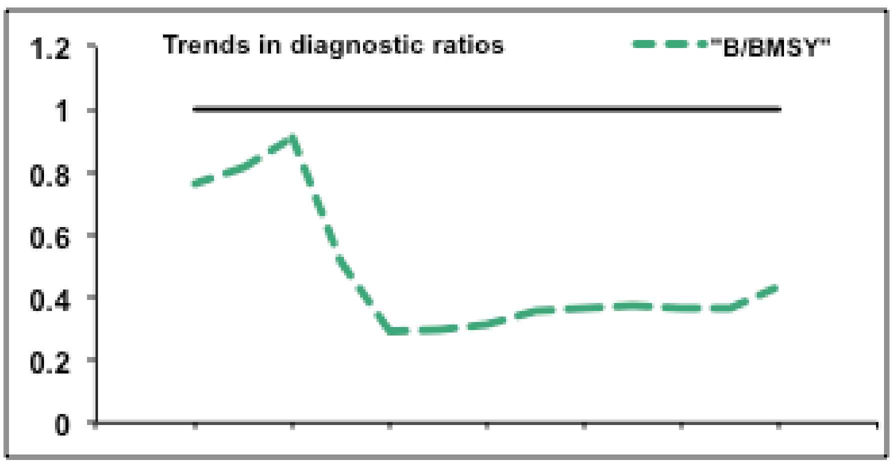


Fig. 6.23.4.1.1.3. Trends in B_i/B_{MSY} over the period 1998-2010.

Current fishing mortality is below the sustainable fishing mortality at current biomass levels (Fig. 6.23.4.1.1.4), but fishing mortality experienced very high fluctuations during the considered period (Fig. 6.23.4.1.1.5-6). Finally, current sustainable production is about the 73% of the MSY (Fig. 6.23.4.1.1.4).

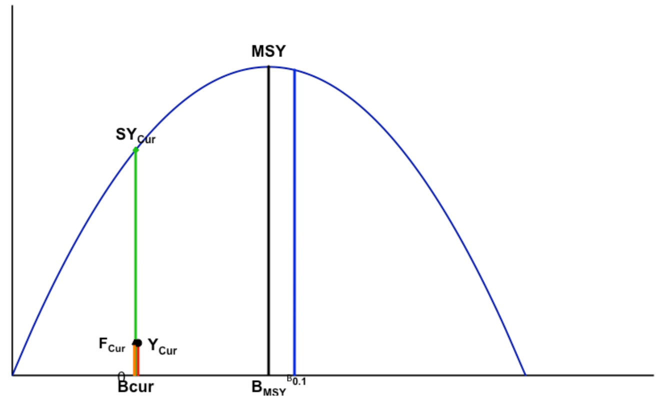


Fig. 6.23.4.1.1.4 Current situation of the sardine stock.

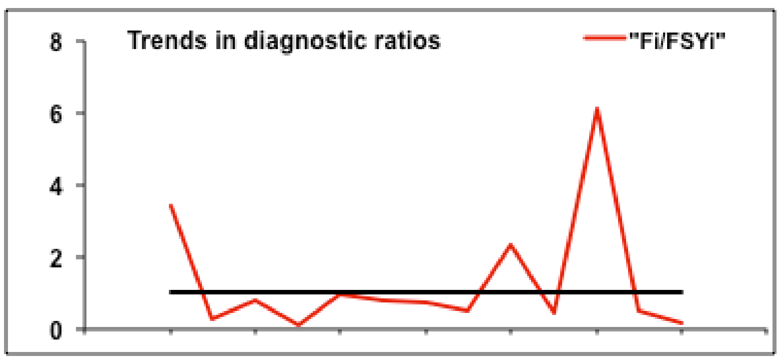


Fig. 6.23.4.1.1.5 Trends in F_i/FSY_i over the period 1998-2010.

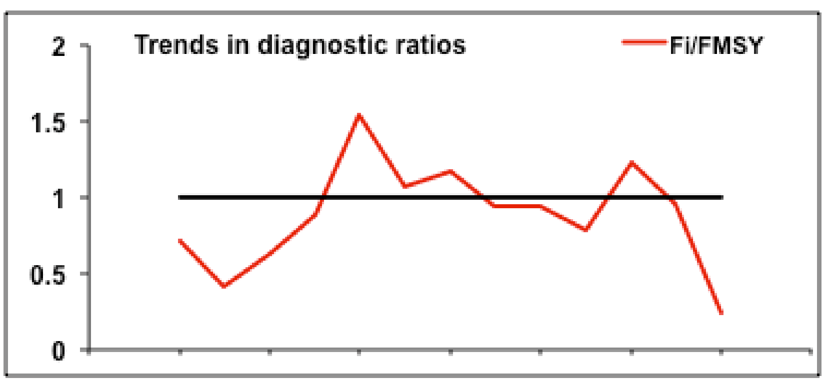


Fig. 6.23.4.1.1.6 Trends in F_i/F_{MSY} over the period 1998-2010.

Though current fishing mortality is far below the sustainable fishing mortality at current biomass levels (Table 6.23.4.1.1.1), fishing mortality experienced high values during the considered period, sometimes above the reference limit (Fig. 6.23.4.1.1.5-6). In addition B/B_{MSY} values were low over the last decade, indicating the stock has been historically overfished.

Table 6.23.4.1.1.1. Reference points. Current estimates refer to year 2010.

MSY	B_{MSY}	F_{MSY}	B_{Cur}/B_{MSY}	F_{Cur}/FSY_{Cur}	F_{Cur}/F_{MSY}
5430	32476	0.17	0.48	0.14	0.22

Actually, given the high sensitivity of this species to changes in environmental conditions, and the instability of the environment on the continental shelf of GSA16 (the habitat for the stock), characterized by coastal wind-induced upwelling and high short term mesoscale variability, it is expected that the sardine stock may experience periods of very different productivity.

6.23.5 Short term prediction

Analysis not performed during the EWG 11-12.

6.23.6 Long term prediction

Not applicable. No forecast analyses were conducted.

6.23.7 Scientific advice

6.23.7.1 Short term considerations

6.23.7.1.1 State of the stock size

Biomass estimates of the total population obtained by hydro-acoustic surveys for sardine in GSA 16 show that the recent stock level has been below the average value over the period 1998-2010. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the status of the stock size.

6.23.7.1.2 State of recruitment

No recruitment data estimates were provided by this assessment.

6.23.7.1.3 State of exploitation

STECF EWG 11-12 recommends the application of the proposed exploitation rate $E \leq 0.4$ as management target for stocks of anchovy and sardine in the Mediterranean Sea, though this value might be revised in the future when more information becomes available. The current (year 2010) harvest F is unusually low (0.04) compared to the estimated average value over the years 2007-2010 (0.15). The very low harvest rate for 2010 appears to be the result of a change in the fishing pattern in favour of anchovy, as the fishing effort remained relatively stable. The exploitation rate corresponding to F=0.15 is equal to E=0.16, if M=0.77, estimated with Pauly (1980) empirical equation, is assumed, and E=0.17 if M=0.72, estimated with Beverton & Holt's Invariants method (Jensen, 1996), is used instead. Thus, using the exploitation rate as a target reference point, the stock of sardine in GSA 16 would be considered as being sustainably exploited.

6.23.7.2 Medium term considerations

The fluctuations in stock biomass cannot be explained solely by the observed fishing pattern. This was an expected result, as pelagic stocks are known to be significantly affected by environmental variability. The incorporation of an environmental index in the model significantly improved the fitting of the model, allowing the stock to grow more or less than average depending on the state of the environment in each year. In the current formulation satellite-based data on chlorophyll concentration showed to have a positive effect on the yearly carrying capacity.

6.24 Stock assessment of common sole in GSA 17

6.24.1 Stock identification and biological features

6.24.1.1 Stock Identification

Tagging experiments carried out on common sole in the northern Adriatic Sea, using the traditional mark-and-recapture procedure, showed that all individuals were re-captured within the sub-basin (Pagotto *et al.*, 1979). Local currents, eddies and marked differences of oceanographic features of this sub-basin with respect to those of southern Adriatic and Ionian Sea (Artegiani *et al.*, 1997) may prevent a high rate of exchange of adult spawners and the mixing of planktonic larval stages from nursery areas of adjacent basins (Magoulas *et al.*, 1996). Guarnieri *et al.* (2002), taking into account differences of sole specimens from five different central Mediterranean areas in the control region sequence marker, suggested that two near-panmictic populations of common sole could exist in the Adriatic Sea. The former population would inhabit the entire GSA 17 (northern Adriatic Sea). The second unit seems to be spread along the Albanian coasts (eastern part of the GSA 18). The hydrogeographical features of this semi-enclosed basin might support the overall pattern of differentiation of the Adriatic common soles.

The northern Adriatic Sea has a high geographical homogeneity, with a wide continental shelf and eutrophic shallow-waters. The southern Adriatic in contrast is characterized by narrow continental shelves and a marked, steep continental slope (1200 m deep; Adriamed, 2000). This deep canyon could represent a significant geographical barrier for *S. solea*.

On these bases, different actions for fishery management should be proposed for the Adriatic common sole stocks in GSA 17 and GSA 18. In the former area the stock is shared among Italy, Slovenia and Croatia, while in the latter one seems to be shared only between Montenegro and Albania.

S. solea is a demersal and sedentary species, living on sandy and muddy bottoms (Tortonese, 1975, Fisher *et al.*, 1987, Jardas, 1996). Although Jardas, (1996) stated that the species is distributed from coastal waters to 250 m depth, it was exclusively caught up to 100 m during the expedition MEDITS (1996-1998) (Vrgoč, 2000).

Common sole usually feeds very often on small quantities of prey (Sà *et al.*, 2003). This suggests a high evacuation rate between the stomach and the intestine, and lack of digestion in the stomach (Lagardère, 1987). The fish feeds night and day and for the remaining time usually lives embedded in the seabed. In the Adriatic Sea food items mostly include invertebrates and small fish (Tortonese, 1975; Fisher *et al.*, 1987; Jardas, 1996). Within the framework of SoleMon project, a study of gut content using carbon- and nitrogen stable isotopes along the sole food web was carried out, indicating that *S. solea* diet depends on both the geographical position and the size of soles, which change their feeding habit with the increase of the age. This could be related to the fact that the sole selects its preys basing on both their energetic value and the energy spent to catch them. The choice of sole would be also related to prey abundance, as postulated by the "*optimal foraging theory*" (MacArthur and Pianka, 1966) and observed in other flatfish (Hinz *et al.*, 2005). Stergiou and Karpouzi (2002) found that in the Mediterranean Sea the sole increases its trophic level with the increasing of the size, reaching values around 3.4. The mean trophic level estimated from the SoleMon project data through the stable isotope analysis was slightly higher (3.9), but similar to the value obtained in a study carried out in the Rodano mouth (Darnaude, 2005).

6.24.1.2 Growth

In the Adriatic sea, growth analyses on this species have been made using otoliths, scales and tagging experiments. A great variability in the growth rate was noted: some specimens had grown 2 cm in one month, while others, of the same age group, needed a whole year (Piccinetti and Giovanardi, 1984; Tab. 6.24.1.2.1). Von Bertalanffy growth equation parameters have been calculated using various methods.

Within the framework of SoleMon project, growth parameters of sole were estimated through the length-frequenzy distributions obtained from surveys (Fig. 6.24.1.2.1; Tab. 6.24.1.2.2).

Tab. 6.24.1.2.1. Growth rates of *S. solea* from different studies. (TL, cm; age, yr).

Author	**Sex**	**Age**					
		1	**2**	**3**	**4**	**5**	**6**
Ghirardelli (1959)	M+F	16.8	21.4	23.9	25.6	33.1	-
Piccinetti and Giovanardi (1984)	M+F	18-20	21-30	-	-	-	-
Vallisneri *et al*. (2000)	F	20	25	29	32	34	37

Tab. 6.24.1.2.2. Von Bertalanffy parameters of *S. solea* estimated in different studies. *(k, yr^{-1}; t_0, yr).

Author	**Sex**	**W_∞(g)**	**L_∞(cm)**	**k ($month^{-1}$)**	**t_0 (month)**
Piccinetti and Giovanardi (1984)	M+F	-	40.10	0.68*	-
Froglia and Giannetti (1985)	M+F	-	38.25	0.041	-3.57
Froglia and Giannetti (1986)	M	323	23.20	0.069	-1.66
	F	562	37.87	0.042	-5.36
	M+F	576	38.25	0.041	-3.57
Fabi *et al.* (2009)	M+F	-	39.60	0.44*	-0.46*

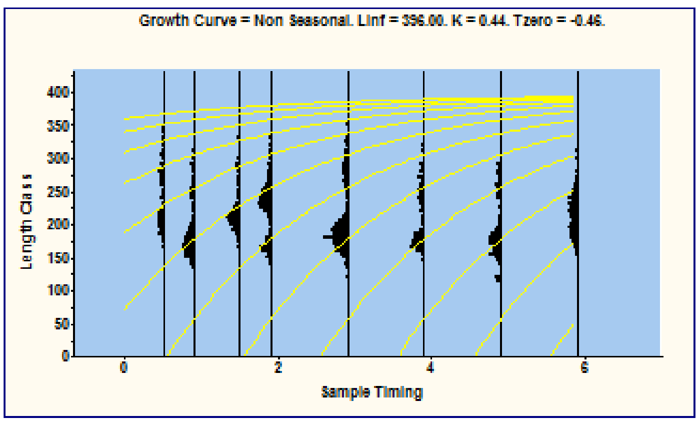


Fig. 6.24.1.2.1 Von Bertalanffy growth functions for sole in the GSA 17, based on SoleMon length frequency distributions (2005-2010).

6.24.1.3 Maturity

In the Mediterranean Sea, the reproduction of common sole occurs from December to May (Bini; 1968-70), Tortonese, 1975, Fisher *et al*., 1987). Within the framework of SoleMon project, it has been observed that in the central and northern Adriatic Sea the reproduction takes place from November to March. Data on the spatial distribution of spawners provided by the project show a higher concentration of reproducers outside the western coast of Istria (Fabi *et al.*, 2009).

Length at first maturity is 25 cm (Fisher *et al.*, 1987; Jardas, 1996; Vallisneri *et al.*, 2000); this value has been estimated at 25.8 using data from SoleMon project. Females having a weight of 300 g have about 150000 eggs, while those weighting 400 g have about 250000 eggs (Piccinetti and Giovanardi, 1984); eggs are pelagic. The male-female ratio is approximately 1:1 (Piccinetti and Giovanardi, 1984; Fabi *et al.*, 2009).

Hatching occurs after eight days and the larva measures 3 to 4 mm TL (Tortonese, 1975). Eye migration starts at 7 mm TL and ends at 10-11 mm TL. Benthic life begins after seven or eight weeks (15 mm) in coastal and brackish waters (Bini (1968-70); Fabi *et al*., 2009).

6.24.2 Fisheries

6.24.2.1 General description of fisheries

The common sole is a very important commercial species in the central and northern Adriatic Sea (Ghirardelli, 1959; Piccinetti, 1967; Jardas, 1996; Vallisneri *et al.*, 2000; Fabi *et al.*, 2009). Italian *rapido* trawlers exploit this resource providing more than 80% of landings. Sole is also a target species of the Italian and Croatian set netters, while it represents an accessory species for otter trawlers.

From censuses carried out at the landing sites, the Italian rapido trawl fleet operating in GSA 17 was made of 155 vessels in 2005 and 124 vessels in 2006 ranging from 9 to 30 m in vessel length, GRT ranged from 4 to 100 and the engine power from 60 to 1000 HP. Each vessel can tow from 2 to 4 rapido trawls depending on its dimensions. The *rapido* trawl is a gear used specifically for catching flatfish and other benthic species (e.g. cuttlefish, mantis shrimp, etc.). It resembles a toothed beam-trawl and is made of an iron frame provided with 3-5 skids and a toothed bar on its lower side. These gears are usually towed at a greater speed (up to 10-13 km h^{-1}) in comparison to the otter trawl nets; this is the reason of the name “*rapido*”, the Italian word for “fast”. The mesh opening of the codend used by the Italian *rapido* trawlers is larger (48 mm stretched or more) than the legal one. The main Italian *rapido* trawl fleets of GSA17 are sited in the following harbours: Ancona, Rimini and Chioggia.

The Italian artisanal fleet in GSA 17, according to SoleMon project data (end of 2006), accounted for 469 vessels widespread in many harbours along the coast. They use gill net or trammel net especially from spring to fall and target small and medium sized sole (usually smaller than 25 cm TL).

6.24.2.2 Management regulations applicable in 2010 and 2011

- Fishing closure for trawling: 30 days in summer.
- Minimum landing sizes: EC regulation 1967/2006: 20 cm TL for sole.
- Cod end mesh size of trawl nets: 40 mm (stretched, diamond meshes) till 30/05/2010. From 1/6/2010 the existing nets will be replaced with a cod end with 40 mm (stretched) square meshes or a cod end with 50 mm (stretched) diamond meshes.
- Towed gears are not allowed within three nautical miles from the coast or at depths less than 50 m when this depth is reached at a distance less than 3 miles from the coast.

6.24.2.3 Catches

6.24.2.3.1 Landings

In the period 2005-2009 common sole landings estimated in the framework of SoleMon project for Italy were quite similar to the official statistic submitted in the data call 2011 (Fig. 6.24.2.3.1.1). Sole landings in GSA 17 fluctuated between 1,300 to about 2,000 tons and although the time series is short, the general shape suggests a stable trend (Fig. 6.241.2.3.1.1).

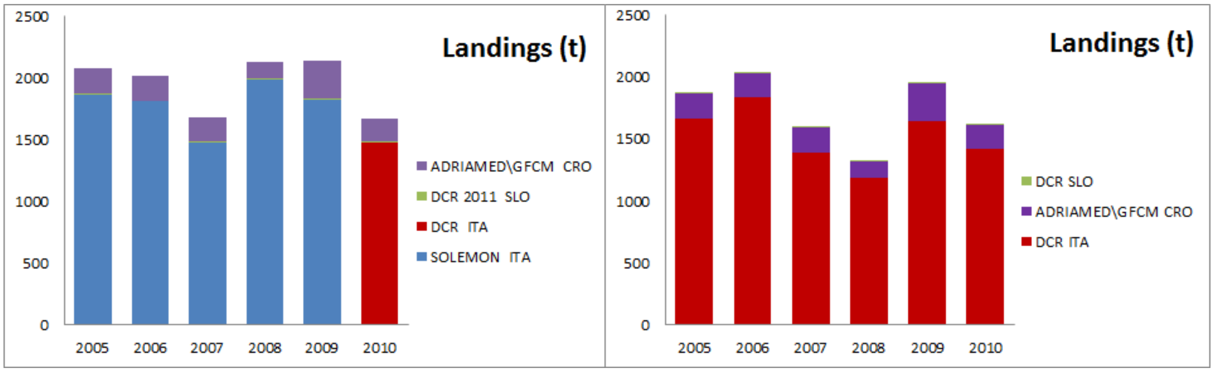


Fig. 6.24.2.3.1.1 Landings of sole (all gears) in the GSA 17, from 2005 to 2010.

The eastern part of the basin contributes for about the 10% of the total landings, with on average 8 tons from Slovenia (2011 official data call) and 200 tons from Croatia (SoleMon project, Adriamed-FAO regional project).

Rapido trawl landings were traditionally dominated by small sized specimens; they are basically composed by 1 and 2 year old individuals. Set net fishery lands mostly the same portion of the population, while the otter trawl fishery, exploiting wider fishing grounds, shows a different size distribution of the landings (Fig. 6.24.2.3.1.2). In the eastern part of the basin common sole is exploited mainly by set netters (using trammel net), the catch composition, as suggested by preliminary data collection started in 2010 by Croatian colleagues in the framework of Adriamed FAO regional project, is dominated by adult (Fig. 6.24.2.3.1.2)

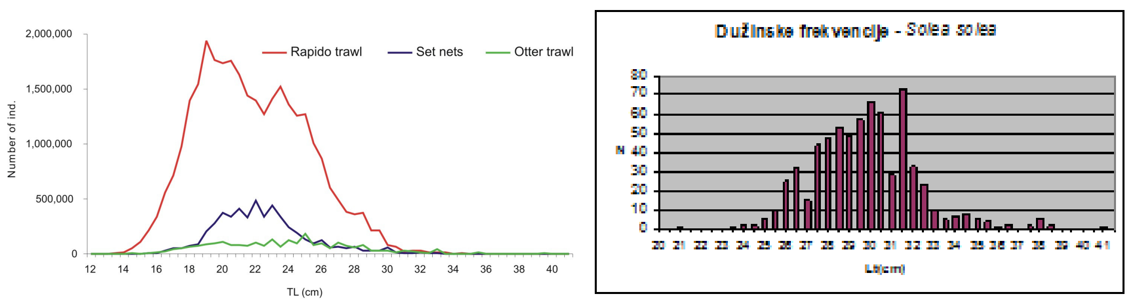


Fig. 6.24.2.3.1.2 Size structure of the landings of common sole provided in 2005-2006 by *rapido* trawl, otter trawl and set nets in the GSA 17 (SoleMon project data; left). Size structure of the landings of common sole in 2010 by set nets in the eastern part of GSA 17 (Adriamed FAO; right).

6.24.2.3.2 Discards

Several projects carried out in a portion of GSA17 highlighted that the discard of sole both by *rapido* trawl and set net fisheries is negligible (Fabi *et al*., 2002; Fabi & Sartor, 2002) as the damaged specimens are also commercialized, even though at a lower price.

6.24.2.4 Fishing effort

Exploitation is based on young age classes, with immature fraction dominating the landings. From DCR official statistics, the overall Italian fleet exploiting sole in the GSA 17 is made up by around 1,300 vessels (rapido trawlers, set netters, otter trawlers; Tabb. 6.24.2.4.1 - 2), while the Slovenian fleet is made up by 30.

Tab. 6.24.2.4.1 Nominal effort (kW x day at sea) exploiting common sole in GSA 17 (DCR data).

		2005	2006	2007	2008	2009	2010
Italy	**GNS**	447644	553394	430752	316980	220012	181627
	OTB	992124	1006558	904445	970286	901425	927683
	TBB	352711	319756	380480	435986	348062	288732
Slovenia	**GNS**	542314	501493	561257	1104997	1198877	1570878
	GTR	655610	636565	1420701	1895691	2312745	2214051

Tab. 6.24.2.4.2 Number of vessels exploiting common sole in GSA 17 (DCR data).

		2005	2006	2007	2008	2009	2010
Italy	**GNS**	3449	1680	1541	1463	1429	1283
	OTB	1445	1272	1074	990	1014	784
	TBB	132	197	166	108	117	104
Slovenia	**GNS**	19	15	16	22	21	21
	GTR	19	18	20	24	27	24

The trends of the fishing effort of Ancona *rapido* trawl fleets have been analyzed over the years 1996-2010. The fishing effort of Ancona fleet increased from 1996 to 2003 and declined in the subsequent years (Fig. 6.24.2.4.1).

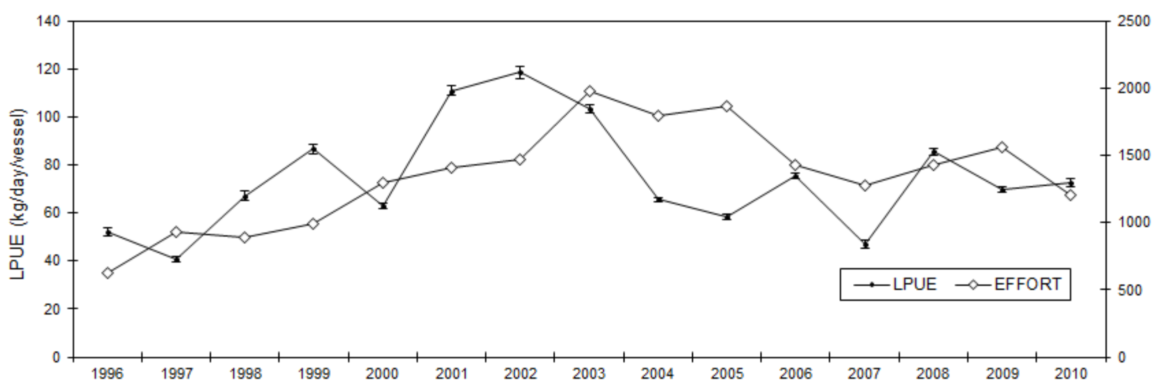


Fig. 6.24.2.4.1 Trends of effort (day · vessel) by Ancona *rapido* trawl fleets

6.24.3 Scientific surveys

6.24.3.1 SoleMon

6.24.3.1.1 Methods

Eight *rapido* trawl fishing surveys were carried out in GSA 17 from 2005 to 2010: two systematic "pre-suveys" (spring and fall 2005) and four random surveys (spring and fall 2006, fall 2007-2008) stratified on the basis of depth (0-30 m, 30-50 m, 50-100m). Hauls were carried out by day using 2-4 *rapido* trawls simultaneously (stretched codend mesh size = 40.2 ± 0.83). The following number of hauls was reported per depth stratum (Tab. 6.24.3.1.1.1).

Tab. 6.24.3.1.1.1 Number of hauls per year and depth stratum in GSA 17, 2005-2010.

Depth strata	Spring 2005	Fall 2005	Spring 2006	Fall 2006	Fall 2007	Fall 2008-2010
0-30	30	30	20	35	32	39
30-50	14	12	10	20	19	17
50-100	24	15	8	8	11	11
HR islands	0	5	4	4	0	0
TOTAL	68	62	42	67	62	67

Abundance and biomass indexes from *rapido* trawl surveys were computed using ATrIS software (Gramolini *et al*., 2005) which also allowed drawing GIS maps of the spatial distribution of the stock, spawning females and juveniles. Underestimation of small specimens in catches due to gear selectivity was corrected using the selective parameters given by Ferretti and Froglia (1975).

The abundance and biomass indices by GSA 17 were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum area in the GSA 17:

$Yst = \Sigma (Yi*Ai) / A$

$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$

Where:

A=total survey area
Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval:

Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the way stations with zero catches are managed, and hence assumptions over the statistical distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien *et al.*, 2004).

Length distributions represented an aggregation (sum) of all standardized length frequencies over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.24.3.1.2 Geographical distribution patterns

According to data collected during SoleMon surveys (Fabi *et al.*, 2009), age class 0+ aggregates inshore along the Italian coast, mostly in the area close to the Po river mouth (Fig. 6.12.3.1.2.1). Age class 1+ gradually migrates off-shore and adults concentrate in the deepest waters located at South West from Istria peninsula.

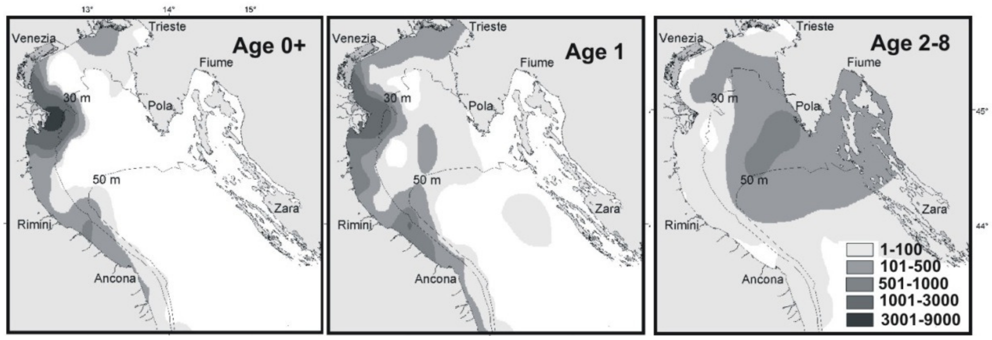


Fig. 6.24.3.1.2.1 Example of abundance indices (ind.· km^{-2}) for sole from SoleMon survey carried out in GSA 17 (fall 2007) interpolated using Kriging (Fabi *et al.*, 2009).

6.24.3.1.3 Trends in abundance and biomass

The SoleMon trawl surveys provided data either on sole total abundance and biomass as well as on important biological events (recruitment, spawning).

Fig. 6.24.3.1.3.1 shows the abundance and biomass indices of sole obtained from 2005 to 2008; slightly increasing trends occurred till fall 2007, followed by a decrease in fall 2008-2009.

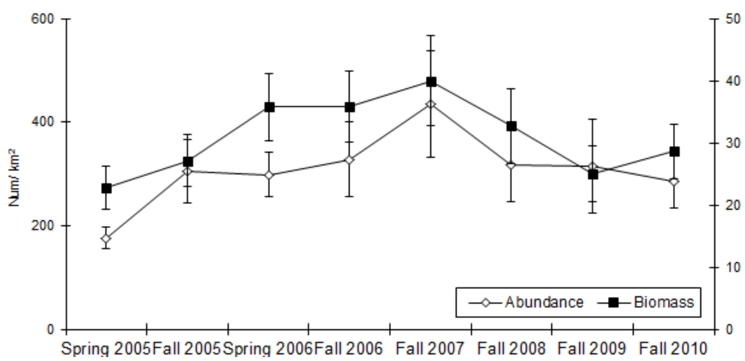


Fig. 6.24.3.1.3.1 Abundance and biomass indices of sole obtained from SoleMon surveys.

The recruitment showed a fluctuating trend with the lowest values in 2006 and 2008 (Fig. 6.24.3.1.3.2). The number and biomass of spawners remained practically constant from 2005 to 2008 and decreased in 2009 (Fig. 6.24.3.1.3.3).

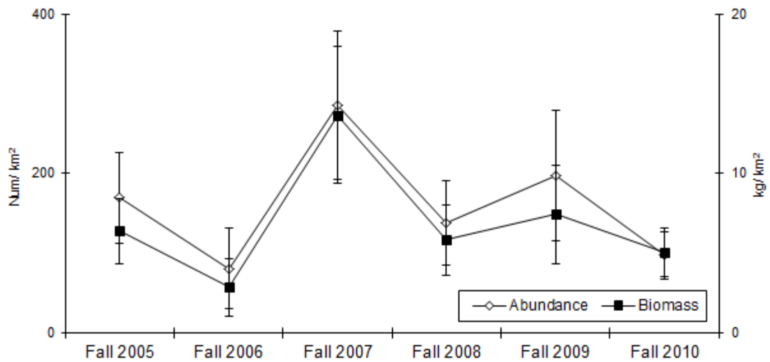


Fig. 6.24.3.1.3.2 Abundance and biomass indices of recruits of sole obtained from SoleMon surveys.

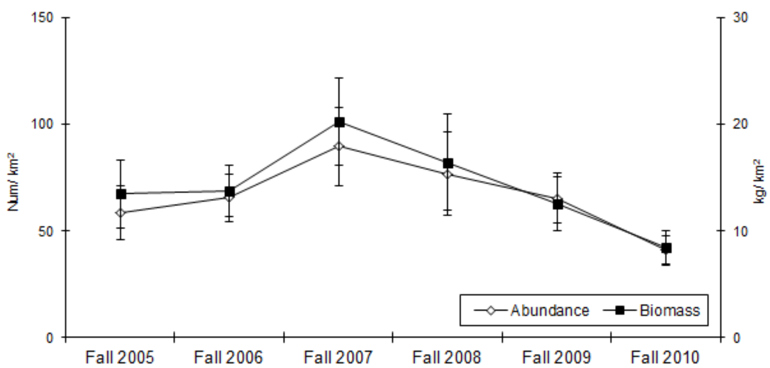


Fig. 6.24.3.1.3.3 Abundance and biomass indices of spawners of sole obtained from SoleMon surveys.

6.24.3.1.4 Trends in abundance by length or age

Fig. 6.24.3.1.4.1 displays the stratified abundance indices obtained in the GSA 17 in the years 2005-2010.

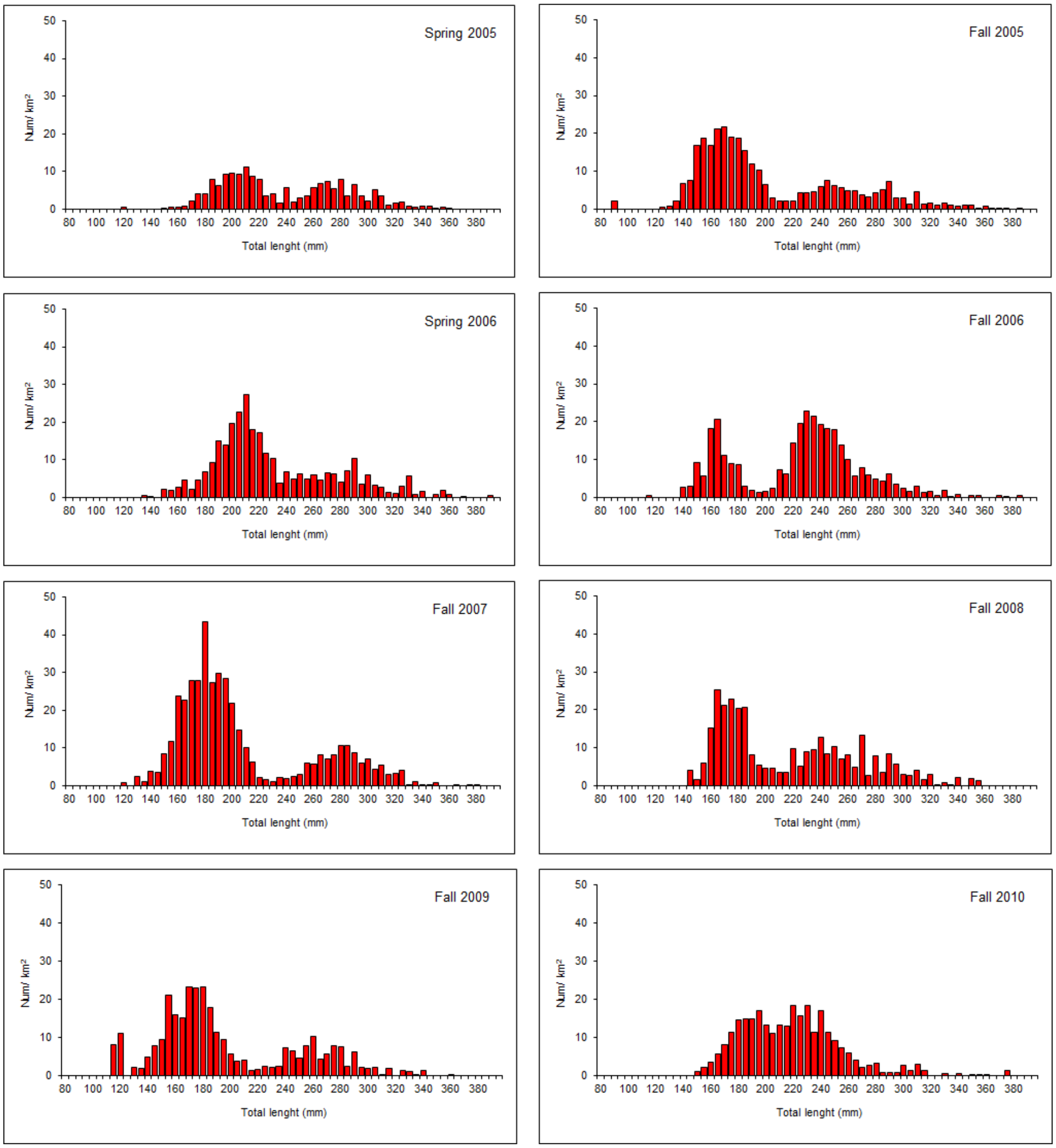


Fig. 6.24.3.1.4.1 Stratified abundance indices by size, 2005-2010.

6.24.3.1.5 Trends in growth

No information was been documented during EWG 11-12 meeting.

6.24.3.1.6 Trends in maturity

No information was been documented.

6.24.4 Assessments of historic stock parameters

Sole has been object of assessments in the GSA17 and results are published and regularly updated in the GFCM SAC sheets and in STECF SGMED. The assessments, often performed with different approaches, showed substantially convergent results.

From the SGMED 10-02 assessment, the sole stock in the GSA 17 seems to be overexploited, as shown by the results of the analytical models (reference points as F_{max}, $F_{0.1}$). An overfishing situation was detected, with high fishing mortality on 1+ and 2+ age classes.

EWG 11-12 has updated the assessment carried out during the SGMED 10-02 with 2010 catch data.

6.24.4.1 Method 1: XSA

6.24.4.1.1 Justification

As described below DCF data were not considered suitable to perform an assessment. So length frequency distributions from SoleMon survey were utilized to calculate the annual total mortality Z. The mean Z from 2005 to 2010 was calculated and the F resulted from the difference with the mean M estimated from the vector calculated by PROBIOM.

6.24.4.1.2 Input parameters

For the first XSA run, catch at age data series of the period 2005-2009, utilised in the in the previous assessments, was extended in 2010 with data provided by 2011 DCF official statistics (Fig. 6.24.4.1.2.1). Italian GNS and OTB catch at age data were missing in DCF 2011 official statistics and have been reconstructed on the basis of the previous year catch composition observed in DCF 2011 official statistics and 2010 landings provided by the same source.

Slovenian catch at age 2010 data were reconstructed on the basis of the official total landings provided by DCR 2011 official statistics and catch at age composition observed for set netters (mainly using trammel nets) collected in the framework of ADRIAMED-FAO regional project in Istria peninsula in 2010.

Croatian catch at age data were reconstructed in 2010 on the base of the total landing suggested by Croatian colleagues (185 tons) and catch at age data composition observed for set netters (mainly using trammel nets) collected in the framework of ADRIAMED-FAO regional project in Istria peninsula.

For the second XSA run, catch at age matrix of the period 2006-2010 were provided by 2011 DCF official statistics. In the case of lacking of data from GNS and OTB a reconstruction of catch at age data has been done as explained for the first run. Similarly Slovenian and Croatian data were the same of the previous XSA run.

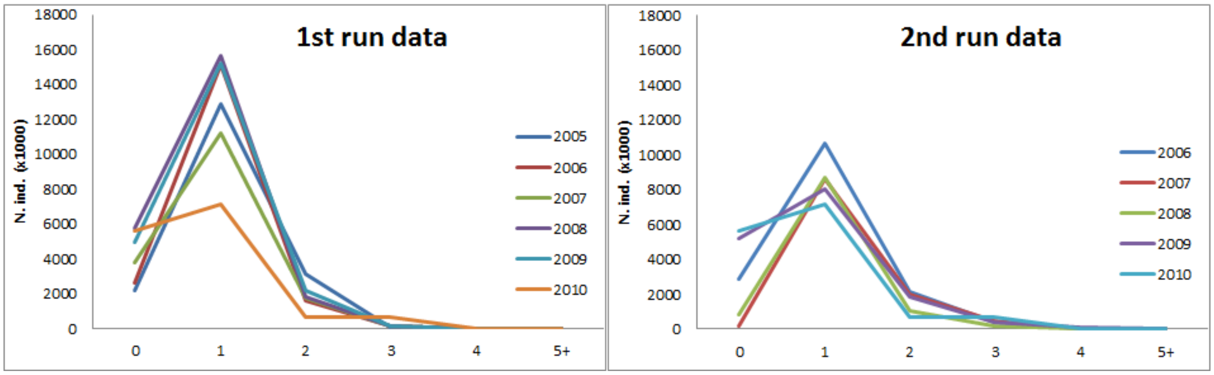


Fig. 6.24.4.1.2.1. Catch at age data used in the VPA and XSA runs.

Maturity at age, Weight-Length relationships, growth parameters were provided in the framework of SoleMon project. Tuning data were provided by SoleMon surveys, carried out in fall for the years 2005-2010.

A vector of natural mortality rate at age was estimated using the PRODBIOM spreadsheet (Abella *et al.*, 1997).

Tab. 6.24.4.1.2.1 Input parameters.

Catch at age in numbers (x 1000) 2nd run						
	0	1	2	3	4	5+
2006	2858	10617	2154	371	46	18
2007	208	8574	1974	496	47	19
2008	799	8681	1058	171	32	12
2009	5180	8051	1840	395	70	28
2010	5614	7124	706	655	29	10

Catch at age in numbers (x 1000) 1st run						
	0	1	2	3	4	5+
2005	2190	12910	3120	138	11	8
2006	2629	15151	1637	159	20	10
2007	3813	11205	1768	186	38	14
2008	5779	15675	1830	181	39	14
2009	4957	15195	2191	190	41	21
2010	5614	7124	706	655	29	10

Survey indexes (N. ind. km^{-2})							
	0	1	2	3	4	5	6+
2005	162	82	39	12	3	2.2	0.36
2006	91	174	49	9	2	1.2	0.3
2007	192	146	74	18	1	0.6	0.2
2008	128	114	58	11	5	0.6	0.1
2009	177	83	47	6	1	0.2	0.1
2010	55	200	23	5	0.2	1.3	0.1

Mean weight in catch						
PERIOD	0	1	2	3	4	5+
2005-2009	0.024	0.104	0.207	0.304	0.380	0.522

Growth parameters			
PERIOD	L_∞	K	T_0
2005-2009	39.6 cm	0.44 y^{-1}	-0.46 y

Length-weight relationships		
PERIOD	a	b
2005-2009	0.007	3.0638

Maturity at Age						
PERIOD	0	1	2	3	4	5+
2005-2009	0	0.16	0.76	0.96	0.99	1.00

Natural mortality (M)						
PERIOD	0	1	2	3	4	5+
2005-2009	0.70	0.35	0.28	0.25	0.23	0.22

6.24.4.1.3 Results

A separable VPA was run as exploratory analysis for both sets of data. Log catchability residual plots were produced (Fig. 6.24.4.1.3.1) and no major conflict between ages seems to appear, except for age 0/1 in 2007 in the second run of the XSA.

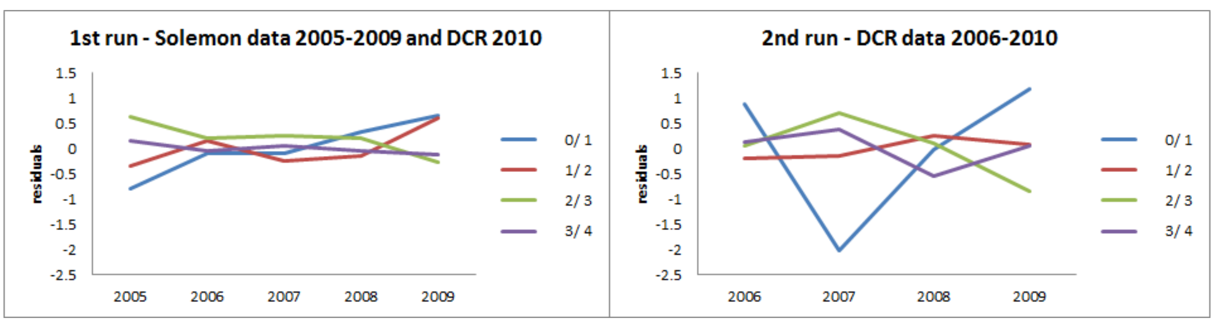


Fig. 6.24.4.1.3.1 Residuals of log catchabilities.

Then XSA runs were made using the following settings:

- F_{bar} 0-4.
- Catchability dependent on stock size for ages < 1.
- Catchability independent of age for ages >= 1
- S.E. of the mean to which the estimates are shrunk = 0.10

- Minimum S.E. for population estimates derived from each fleet = 0.30

XSA Diagnostics for each run in the form of residuals by survey data are shown in the figure 6.24.4.1.3.2.

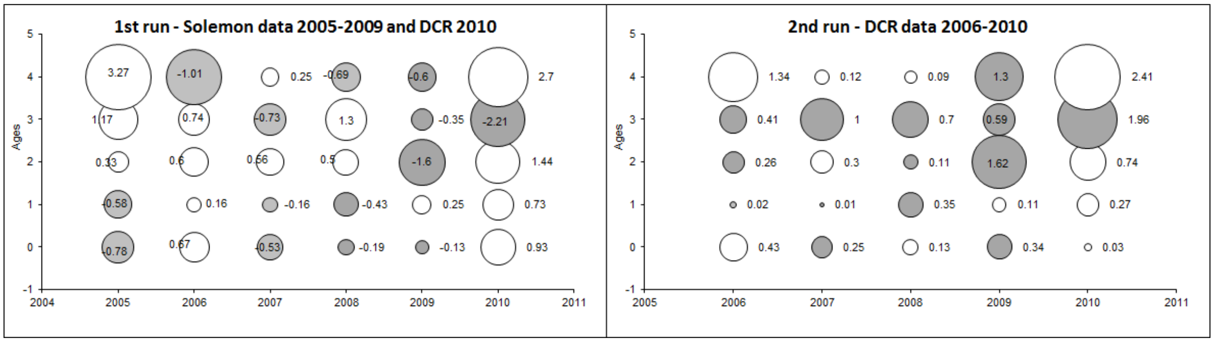


Fig. 6.24.4.1.3.2 Log transformed catchability residuals by survey.

In both cases no trends in the residuals were observed. The inclusion of tuning data from CPUE of *rapido* trawl commercial fleet of Rimini did not provide additional information or different results. Therefore, the definitive assessments only included tuning data from SoleMon survey. The figures 6.24.4.1.3.3 present the main results from the first XSA run: fishing mortality, relative F at age, total biomass, spawning stock biomass (SSB), recruitment.

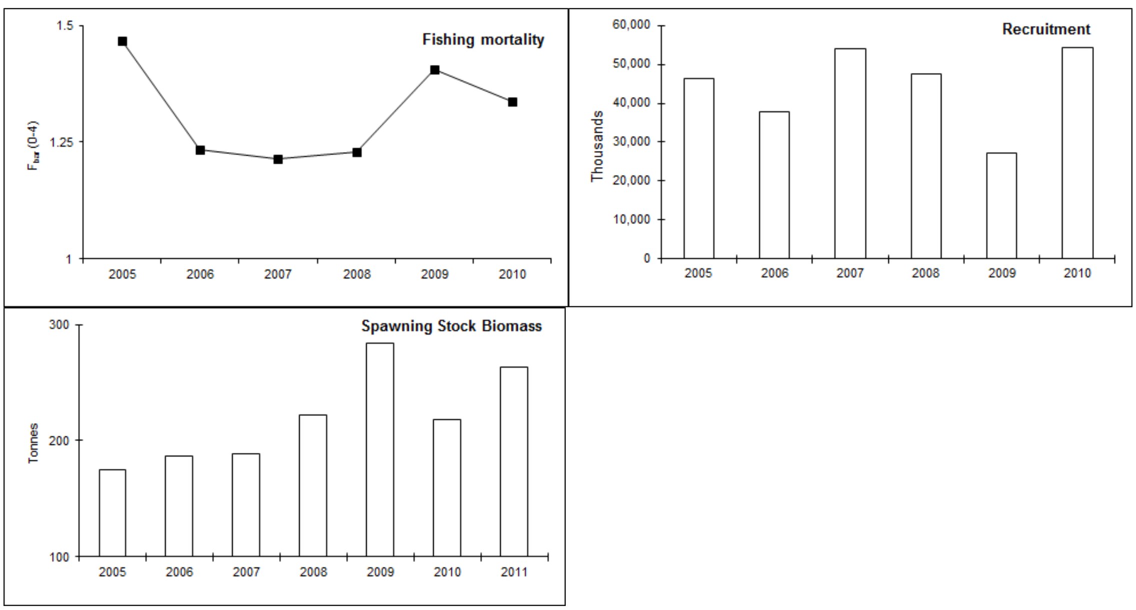


Fig. 6.24.4.1.3.3 Final assessment results first XSA run.

State of exploitation: Exploitation decreased from 2005 to 2006, was constant in 2006-2007 and increased in 2008-2010. The most recent estimate of fishing mortality ($F_{0\text{-}4}$) is 1.34.

State of the juveniles (recruits): Recruitment varied without any trend in the years 2005-2010, reaching a minimum in 2009, and increasing in 2010

State of the adult biomass: The SSB regularly increased from 2005 to 2009, decreased in 2010 and the projection calculated on the basis of the survivor in 2011 shows an increase with values comparable with 2009.

The Fig. 6.24.4.1.3.4 present the main results from the second XSA run: fishing mortality, relative F at age, total biomass, spawning stock biomass (SSB), recruitment.

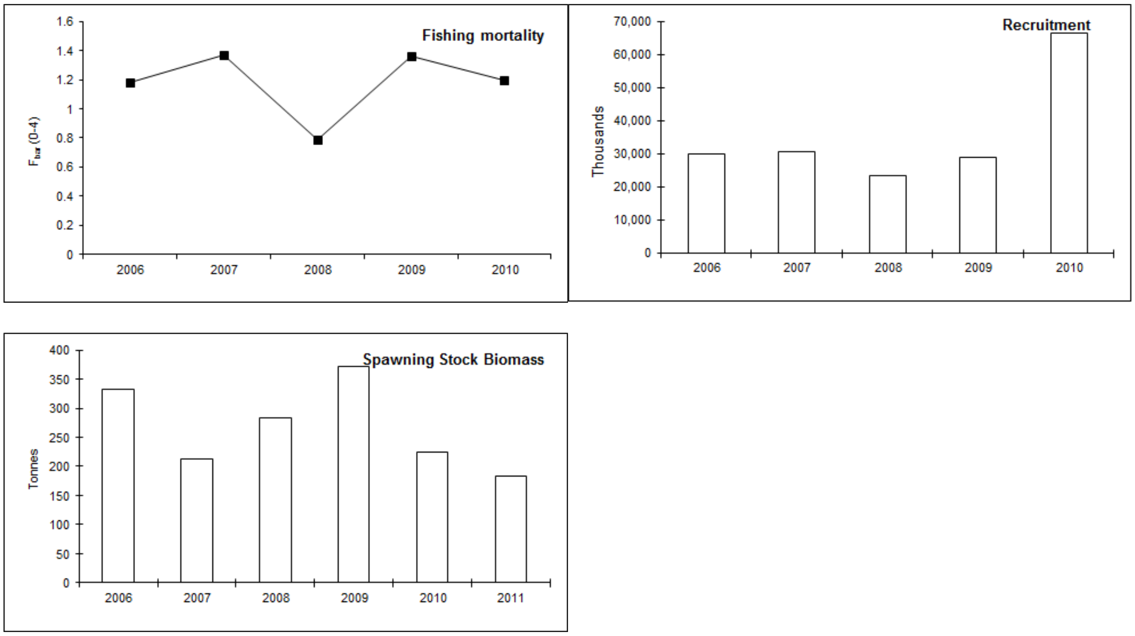


Fig. 6.24.4.1.3.4 Final assessment results second XSA run.

State of exploitation: Exploitation was constant in the period analysed expect for the lower value observed in 2008. The most recent estimate of fishing mortality ($F_{0\text{-}4}$) is 1.20.

State of the juveniles (recruits): Recruitment varied without any trend in the years 2006-2009, reaching the maximum in 2010.

State of the adult biomass: after the decrease observed from 2006 to 2007 the SSB regularly increased from 2007 to 2009, and decreased again in 2010 and in the projection calculated on the basis of the survivor in 2011.

6.24.4.2 Method 2: SURBA

6.24.4.2.1 Justification

The availability of a time series of data from SoleMon surveys allows the use of the SURBA assessment tool. Using the software, the evolution of fishing mortality rates of sole in the GSA 17 was reconstruct starting from the analysis of the length frequency distribution (LFD).

6.24.4.2.2 Input parameters

The main input parameters to run the SURBA-survey based stock analysis are abundances from the SoleMon survey (n. ind/ km^2; Table 6.24.4.2.2.1). The following set of parameters was adopted:

Natural mortality
M vector Age_0=0.7 , Age_1=0.35, Age_2=0.28, Age_3=0.25, Age_4=0.23, Age_{5+}=0.22
Catchability (q)
q(age 0+) = 0.5, q(age 1+) = 1.0, q(age 2+)=1, q(age3+)=1, q(age 4+)=1, q(age 5+)=1

Maturity ogive
Prop. of mature Age_0=0 , Age_1=0.16, Age_2=0.76, Age_3=0.96, Age_4=0.99, Age_{5+}=1
Stock weights at age
Mean weights (kg) Age_0=0.024 , Age_1=0.104, Age_2=0.207, Age_3=0.304, Age_4=0.380, Age_{5+}=0.522

Table 6.24.4.2.2.1Abundances values used in the SURBA model.

N. ind/ km^2	Age 0	Age 1	Age 2	Age 3	Age 4	Age 5+
2005	162.0	86.3	39.3	11.8	3.5	2.2
2006	90.7	174.6	49.4	9.2	2.1	1.2
2007	192.5	146.7	74.9	18.0	1.4	0.6
2008	128.1	114.8	57.6	10.6	5.4	0.1
2009	177.3	83.2	46.6	5.5	1.3	0.2
2010	54.9	200.6	22.7	4.9	0.2	1.4

6.24.4.2.3 Results

The results and the diagnostic of the analyses are summarized in Figures 6.24.4.2.3.1 and 6.242.4.2.3.2 respectively. The results of the model are in general accordance with the previous method providing the same perception of the exploitation of the stock ($F_{0\text{-}4}$=1.15). Moreover a clear decreasing trend in SSB is showed as well as the low recruitment in the last year (cohort effect). Diagnostic plots of SURBA models (Figure 6.24.4.2.3.2) show an adequate fitting of the model in sole data in GSA 17 and absence of trends in the residuals.

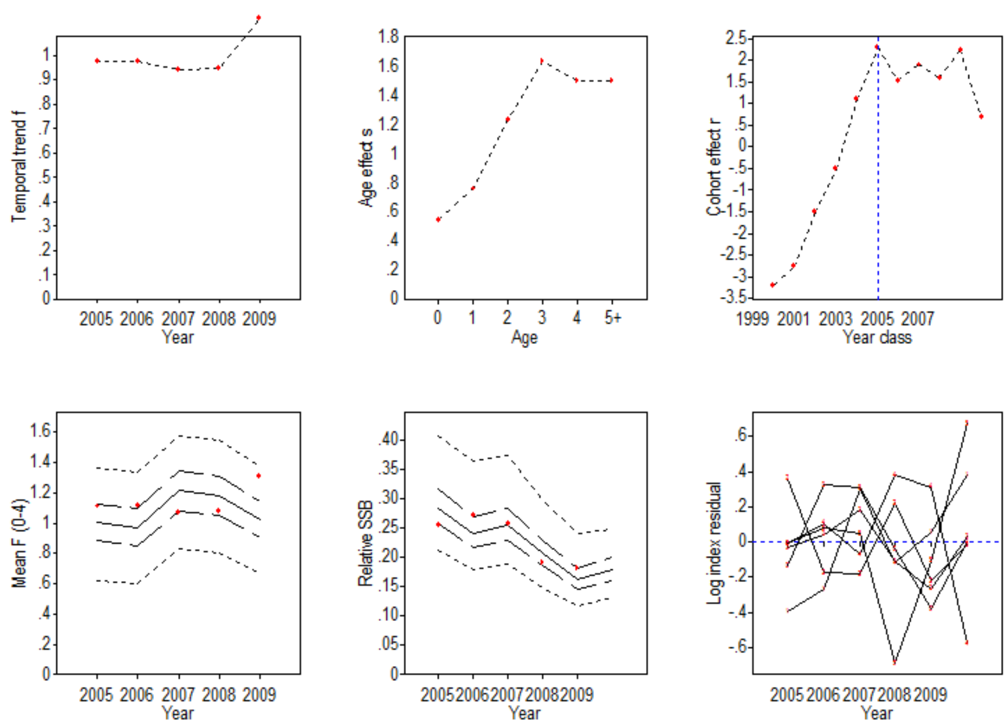


Fig. 6.24.4.2.3.1 Trends in stock parameters (SoleMon survey) in GSA 17 from SURBA.

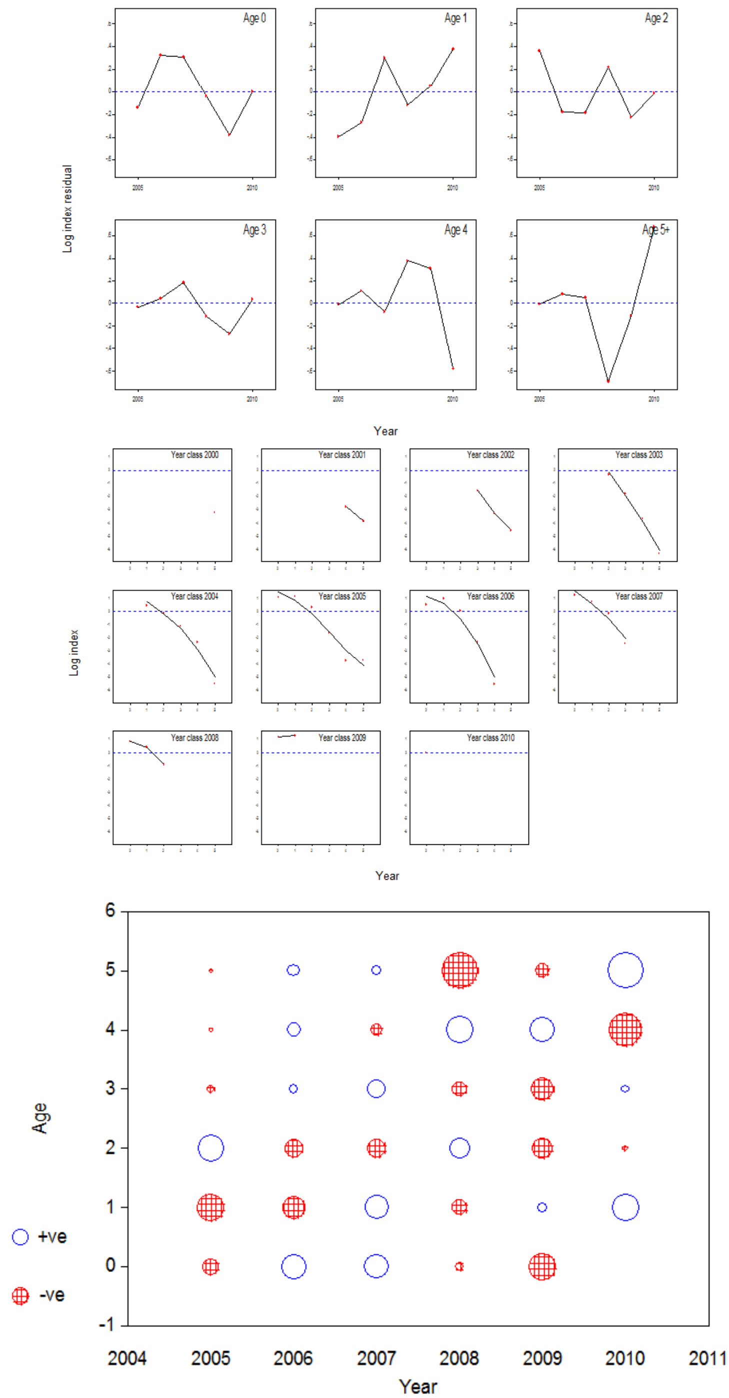


Fig. 6.24.4.2.3.2. Model diagnostic (SoleMon survey) in GSA 17 from SURBA. Residuals trends; comparison between observed (points) and fitted (lines) of survey abundance indices, for each year; bubble plot of log-index residuals by age.

6.24.5 Short term prediction

Will be accomplished during the follow up meeting 16-20 January 2012.

6.24.6 Long term prediction

6.24.6.1 Justification

The same analysis performed in the SGMED-10-02 was used for estimating the biological reference points (BRP).

6.24.6.2 Input parameters

Growth, length-weight relationship, natural mortality and maturity ogive were the same used in the previous paragraphs. Length at first capture was 16 cm TL (about 0.7 year old).

A guess estimate of uncertainty in terms of coefficient of variation (CV=0.2) was added to each parameter.

Beverton and Holt stock-recruit relationship commonly employed for North Sea flatfish (Kell *et al.*, 2005; Pilling *et al.*, 2008) was used with steepness of 0.9 and virgin SSB of 13000 t. The value of steepness represents a hypothesis based on the high resilience of the stocks at low spawning-stock size. The value of virgin SSB was estimated from previous analyses carried out by VIT package. The recruitment variability among years was estimated as CV=0.3 from recruit indices obtained in trawl surveys.

6.24.6.3 Results B

Estimation of Y and SSB per recruit are shown in Fig 6.24.6.3.1

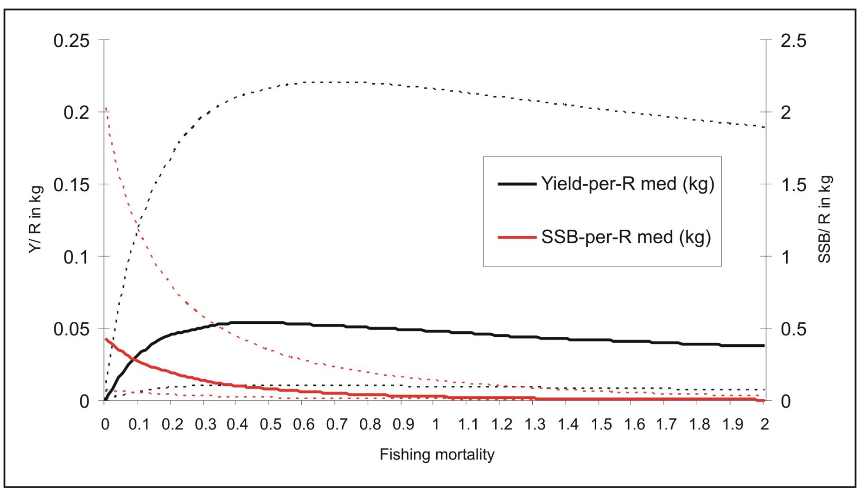


Fig. 6.24.6.3.1 Yield and spawning stock biomass per recruit and corresponding uncertainty of sole in the GSA 17 according to the Yield Package.

Searching for BRP through 1000 simulation produced the median values reported in table 6.24.6.3.1. Y/R_{max}, F_{max} and Y/R_{ref}, F_{ref}, the two latter corresponding to Y/R and F at SSB/initial SSB = 0.30, were assumed as limiting reference points. Whereas $Y/R_{0.1}$ and $F_{0.1}$, should be considered as limit reference points.

RPs suggest an overfishing situation for the stock considering F current (1.36 from XSA) is much higher than the F_{msy} value.

The effect of several bad recruitment years in a row has been evaluated using the transient analysis of SSB. A fishing mortality rate of 0.24 will result in a probability of 0.1 of the SSB falling below 0.2 of its unexploited level at least once in 20 years.

Tab. 6.24.6.3.1 Yield (kg) per recruit and fishing mortality based BRP of sole for GSA 17 according to the Yield package.

Yield based RP	value	F based RP	Value
Y/R_{max}	0.054	F_{max}	0.46
Y/R_{ref}	0.051	F_{ref}	0.32
$Y/R_{0.1}$	0.048	$F_{0.1}$	0.26

6.24.7 Data quality and data consistency

Common sole 2011 DCF data in GSA17 are delivered by Italy and Slovenia, because the latter contribute for less than 1%, data quality analyses focused only for the Italian data.

For sole in GSA17 landings at age and at length were available only for beam trawl from 2006 to 2010, no data from gillnet and otter trawl were available with continuity for the same time period.

As regarding the total landings, there is an high level of similarity comparing the official DCR data and the data collected in the framework of SoleMon project used in the previous assessment.

Differences in the comparison between total landing data submitted in the previous official DCF data and 2011 official DCF data were observed.

The comparison between total landings and landings reconstructed as the sum of the landings at age evidenced differences from 3 to 25% of the total landings by gear and year (Fig. 6.24.7.1). Moreover differences in the selectivity pattern of 2009-2010 TBB landings from the previous year were observed.

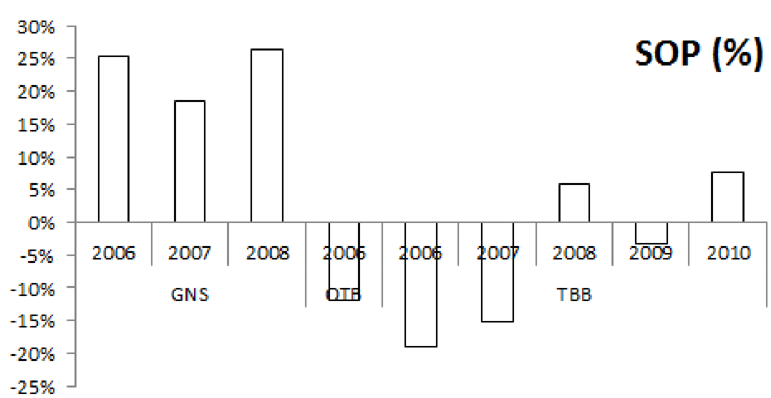


FIG. 6.24.7.1. Differences in percentage between the declared landings and the reconstructed landings as sum of products (2011 DCF data).

In the previous assessment, data on sole were not available from the Croatian part; because sole is considered under the “mixed flatfish” category in the Croatian fishery statistics. However, landings of around 200 t of *S. solea* per year have been suggested for the period 2005-2007, while for 2008 and 2009 information of total landing were provided by GFCM statistics (GFCM: XXXIV/2010/Inf.9; GFCM: XXXV/2011/Inf.4). The length frequency distributions from 2005 to 2009 of the Croatian catches derived from the demography of common sole observed in the hauls performed close to the Croatian waters during the SoleMon survey. In 2010, data provided by Croatian colleagues regarding the total landing (185 tons) and size/age composition of the catches of set netters (mainly using trammel net) were used to reconstruct the catch at age matrix.

The official survey data from MEDITS were not used in the present nor in the previous assessments (SGMED-09-02, SGMED-10-02), because the otter trawl net used in the MEDITS survey has very low catchability for species as common sole, thus does it not provide data representative on the status of the stocks. The use of independent SoleMon survey date were useful in the present assessment to provide an overall perception of the status of the stock but also tuning values for the XSA and input data for the SURBA analysis.

6.24.8 Scientific advice

6.24.8.1 Short term considerations

6.24.8.1.1 State of the spawning stock size

According to the XSA and SURBA analyses the SSB was practically constant in the period considered but, taking into account the high values of relative F for the oldest ages, the stock is considered overexploited. In the absence of a precautionary reference point STECF EWG 11-12 is unable to fully evaluate the state of the stock size.

6.24.8.1.2 State of recruitment

According to XSA and SURBA analyses the recruitment of sole in GSA 17 fluctuated since 2005 without a clear trend.

6.24.8.1.3 State of exploitation

The STECF EWG 11-12 propsed F0.1=0.26 (Fmsy proxy) as limit management reference point consistent with high long term yields and low risk of fisheries collapse. Based on the XSA estimates, in 2010 the fishing mortality F=1.2 exceeds $F_{0.1}$ and, hence, it can be concluded that the resource is subject to overexploitation.

EWG 11-12 recommends that fishing effort should be reduced until fishing mortality is below or at the proposed level F_{msy}, in order to avoid future loss in stock productivity and landings.

6.24.8.2 Medium term considerations

Considering the results of XSA analyses, it can be concluded that the resource is over-exploited. A reduction of fishing pressure, especially by *rapido* trawling, would be recommended, also taking into account that the exploitation is mainly orientated towards juveniles and the success of recruitment sems to be strictly related to environmental conditions (Domenichetti *et al.*, 2009). Hence, in the case of both increasing fishing effort and yearly bad recruitment, there could be a high risk of stock depletion. A two–months closure for rapido trawling inside 11 km off-shore along the Italian coast, after the biological fishing ban (August), would be advisable to reduce the portion of juvenile specimens in the catches. For the same reason, specific studies on rapido trawl selectivity are necessary. In fact, it is not sure that the adoption of a larger mesh size would correspond to a decrease of juvenile catches, considering that the mesh opening currently used by the Italian rapido trawlers is larger (48 mm or more) than the legal one. The same uncertainty regards the adoption of a square mesh.

SSB showed general stable trends in the XSA run, probably because, as observed during the SoleMon project, in late fall - winter the main spawning area is only partially exploited by the Croatian set netters and Italian fleets (Figure 6.24.8.2.1). The safeguard of such area (identified by the *rapido* trawl survey) to prevent a possible future exploitation might be crucial for the sustainability of the Adriatic sole stock.

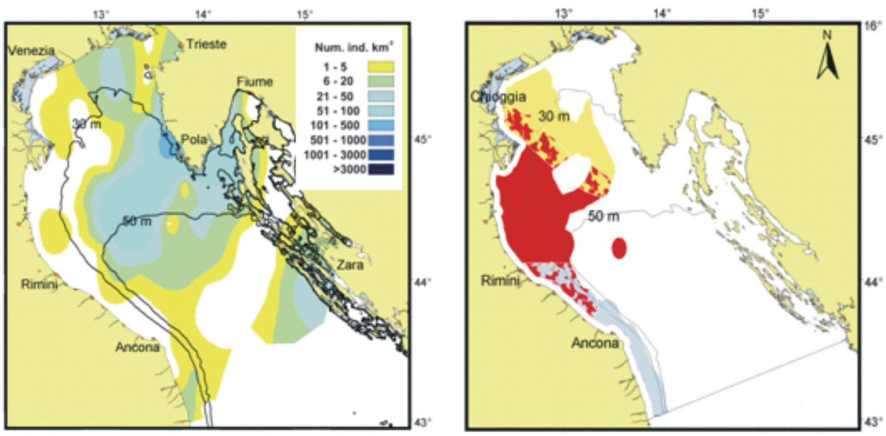


Figure 6.24.8.2.1 Spatial distribution of spawning females in fall (left) and fishing grounds of the Italian rapido trawl fleets (right; in yellow Chioggia rapido trawl fleet; in red Rimini rapido trawl fleet; in light blue Ancona rapido trawl fleet).

On the contrary the SSB estimated by the SURBA model showed a decreasing trend, as confirmed by the decrease of the spatial distribution of adult specimens observed from 2005 to 2010 (Fig 6.24.8.2.2).

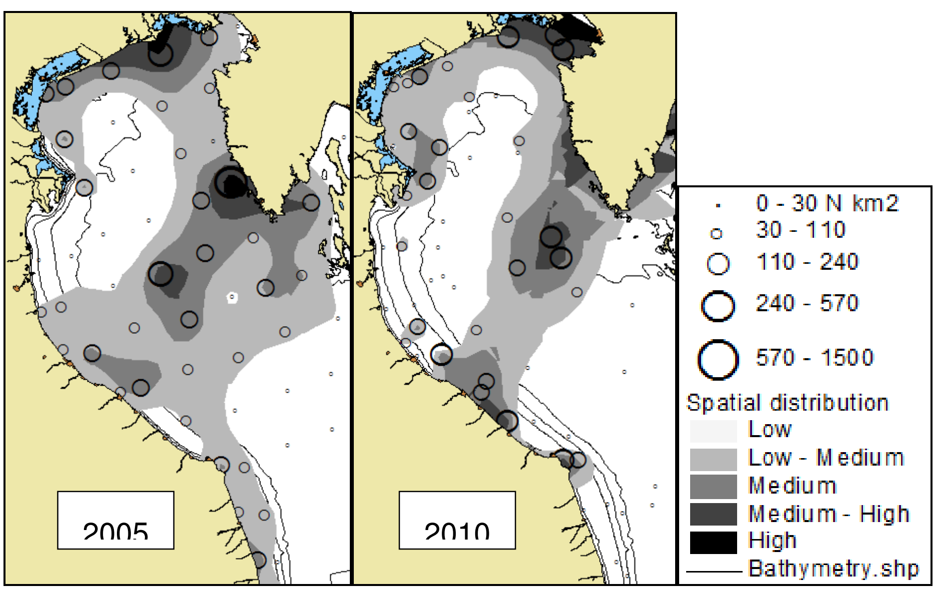


Figure 6.24.8.2.2 Spatial distribution of adult specimens in 2005 and 2010.

6.25 Stock assessment of picarel in GSA 25

6.25.1 Stock identification and biological features

6.25.1.1 Stock Identification

Picarel (*Spicara smaris*) is a common demersal fish in the Mediterranean Sea, found in depths ranging from 10-200 meters, and mostly distributed in depths less than 100 m. It inhabits sandy and muddy bottoms. The species in GSA 25 is considered as a single stock, though this has not been evidenced by studies on population structure.

6.25.1.2 Growth

The von Bertalanffy growth parameters of red mullet in GSA 25 were estimated using otolith readings; the estimates for sex combined data, for the years 2006-2008, are the following: L_{inf} = 19.57, k=0.2678 and t_0=-2.084.

Parameters of the length-weight relationship, related to sex combined data for the years 2006-2008, are: a=0.00679, b = 3.119 (for length expressed in cm).

The data used for the growth parameters were collected under the Cyprus National Data Collection Programme, within the Data Collection Regulation framework, and were provided through the 2010 Official EC Data Call.

6.25.1.3 Maturity

The maturity ogive of the stock (sex combined), as provided through the 2010 Official EC Data Call, is presented in Table 6.25.1.3.1. Data used were collected under the Cyprus National Programme during 2006-2008.

Tab. 6.25.1.3.1: Maturity ogive data of *S. smaris*

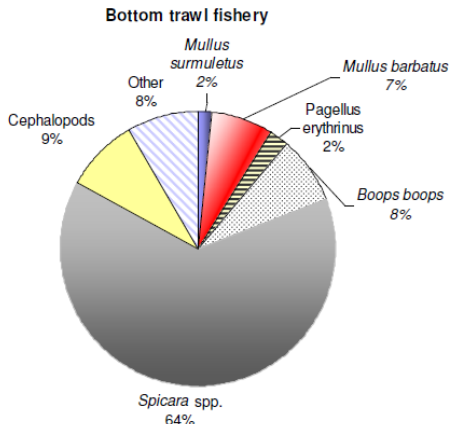
Age	0	1	2	3	4	5
Prop. Mature	0.79	0.85	0.90	0.85	0.97	0.96

6.25.2 Fisheries

6.25.2.1 General description of fisheries

S. smaris in GSA 25 is exploited with other demersal species by the bottom otter trawlers and the artisanal fleet using set nets (basically trammel nets) and only occasionally by purse seine.

In the trawl fishery the main species caught with *S. smaris* are: *Spicara maena*, *Boops boops*, *M. surmuletus*, *M. barbatus*, *Pagellus erythrinus* and cephalopods (*Octopus vulgaris*, *Loligo vulgaris* and *Sepia officinalis*). The artisanal (inshore) fishery catches also relatively large quantities of *Diplodus* spp, *Sparisoma cretense* and *Siganus* spp. The average percentage of *S. smaris* in the overall landings of the bottom trawl and artisanal fishery, for the period 2006-2008, was 64% and 9% respectively (Fig. 6.25.2.1.1).



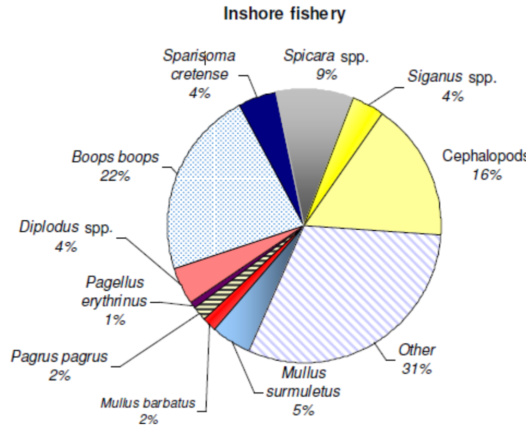


Fig. 6.25.2.1.1. Composition of landings of the artisanal and trawl fishery in Cyprus for the period 2006-2008.

6.25.2.2 Management regulations applicable in 2010 and 2011

The Governmental Policy for the Fisheries Sector, which is harmonized with the Common Fisheries Policy, aims at the reasonable and sustainable management of the fisheries resources and on the support of the economic contribution of the fisheries sector for the improvement of the income of those dependent on this sector.

The National and Community legislation provide for a number of management measures for the regulation of the Cyprus fisheries, including:

1. Restrictive access to the fisheries (limited number of licenses for each fleet segment)
2. Effort control:
    - Restrictions on the use of fishing gears (quantities, soaking time, depth and distance off shore)
    - Restriction of number of fishing days
    - Regulation of fishing capacity (scrapping, assignment for other uses than fishing, engine restrictions, ceiling of the fleet vessel register).
3. Market restriction measures: minimum landing sizes.
4. Technical conservation measures: minimum mesh sizes and type of nets or longlines
5. Seasonal and area closures.

The national management measures employed within the territorial waters for each fishery, in addition to the measures imposed by the Community legislation, are mainly based on the Adjustment Plan. More specifically, the national management measures imposed for each fleet segment are the following:

<u>Small scale inshore fishery</u>

- Restriction of the maximum number of licenses. Since 2008 assignment of licensed fishermen in 3 categories (A, B, C), based on their fishing activity and certain criteria. Licenses A and B restricted up to 500 and Licenses C restricted up to 1200. [Legal base: Article 13 (3) (a) (i) of Fisheries Law (Chapter 135 and Laws from 1961 to 2007].
- Change of activity. 58 small scale fishing vessels have changed their activity during 2010-2011. This measure is part of the Adjustment Plan, aiming the reduction of fishing licenses.
- Restriction of maximum licenses of category C at 30%. This measure is part of the Adjustment Plan, aiming the reduction of fishing licenses.
- Restrictions on the use of fishing gears depending on the fishing license category.

For licenses A and B:

- Until 10th of March 2011, minimum mesh size of nets was set at 32mm (open mesh size). [Legal base: [Article 13 (3) (a) (ii) of Fisheries Law (Chapter 135 and Laws from 1961 to 2007) and relevant decision]. From 10th March 2011 minimum mesh size of nets is set at 38mm for all types of nets (twine or monofilament; Legal base: [Administrative Act 70/2011- Decision based on Article 13(3)(a)(ii) of Fisheries Law].
- Maximum length of nets for boats with license B, independently of the number of fishermen on-board: 3000m. [Legal base: Fisheries Regulations 1990-2009, Regulation 21 (4)].
- Maximum length of nets for boats with license A: 5000m (even in the case of a third fisherman on-board) [Legal base: Fisheries Regulations 1990-2009, Regulation 21 (3)].
- Restrictions on the time and duration of fishing, depending on type of nets and area. [Fisheries Regulations 1990-2009, Regulation 8(1)].
- Restriction on the allowable fishing depth of nets from 1st of June – 30 September each year at 5 m [Fisheries Regulations 1990-2009, Regulation (2)]

For licenses C:

- Until 10th of March 2011 minimum mesh size of nets at 36mm (open mesh size) [Article 13 (3) (a) (ii) of Fisheries Law (Chapter 135 and Laws from 1961 to 2007) and relevant decision].
- From 10th March 2011 minimum mesh size of nets is set at 38mm, measured in accordance with Regulation (EC) No. 517/2008. (Legal base: [Administrative Act 70/2011- Decision based on Article 13(3)(a)(ii) of Fisheries Law].
- Prohibition of the use of monofilament nets [Article 13 (3) (a) (ii) of Fisheries Law (Chapter 135 and Laws from 1961 to 2007) and relevant Decision].
- Restriction on the use of set longlines: Maximum number of two with maximum number of 200 hooks [Article 13 (3) (a) (ii) of Fisheries La (Chapter 135 and Laws from 1961 to 2007) and relevant Decision].
- Prohibition of the use of surface longlines [Article 13 (3) (a) (ii) of Fisheries Law (Chapter 135 and Laws from 1961 to 2007) and relevant Decision].
- Maximum length of nets: 600 m. [Article 13 (3)(e)(iii) of Fisheries Law (Chapter 135 and Laws from 1961 to 2007)].
- Restriction of number of fishing days at 70 days annually, during weekends of certain months [Article 13 (3) (e) (i), (ii) of Fisheries Law (Chapter 135 and Laws from 1961 to 2007)].

Control measures – use of VMS

The use of VMS is compulsory to all professional fishing vessels with license of small scale inshore fishery A’ and B’ Category. [Fisheries Regulations 1990-2009, Regulation 10(A)].

<u>Polyvalent vessels</u>

- From 10th March 2011 minimum mesh size of nets is set at 38mm for all types of nets (twine or monofilament), measured in accordance with Regulation (EC) No. 517/2008. [Administrative Act 70/2011- Decision based on Article 13(3)(a)(ii) of Fisheries Law].
- It is noted that under the “Adjustment Programme for part of the Fishing Fleet of the Republic of Cyprus within the scope of Regulation (EC) 744/2008”, which was approved by the European Commission, 12 polyvalent vessels were permanently withdrawn in the period 2009-2010. Furthermore, there is a reduction of fishing licenses of polyvalent vessels at 15% (from a total of 25), for a period of at least 4 years.

Control measures – use of VMS

The use of VMS is compulsory to all professional fishing vessels with polyvalent license (even less than 15m length). [Fisheries Regulations 1990-2009, Regulation 10(A)].

<u>Bottom Trawl Fishery</u>

- Restriction of the maximum number of licenses [Article 13 (3) (a) (i) of Fisheries Law (Chapter 135 and Laws from 1961 to 2007]. Since 2006, the maximum number of licenses is restricted to 4 (see Section 7 for new restriction measure).
- Closed trawling period from 1st of June until the 7th of November [Fisheries Regulations 1990-2009, Regulation 21(1) (a)]
- Prohibiton of bottom trawling in the Zygi coastal area, at a distance of 3 nautical miles from the coast [Administrative Act 465/2008 - Order based on Article 5A of the Fisheries Law].
- Until June 2010 the minimum mesh size of the trawl net was 40mm (diamond shape); from June 2010 the trawl net was replaced at the cod end by a diamond meshed net of 50 mm, in accordance with the provisions of the Mediterranean Regulation (EC) No 1967/2006.
- Minimum landing sizes are in accordance with Annex III of the Mediterranean Regulation.
- Minimum distance: Cyprus has requested derogation, for trawlers to operate between 0.7 and 1.5 nautical miles off the coast (where sea depth is no less than 50m isobath), in accordance with Article 13 (11) of the Mediterranean Regulation. This request is based on geographical constraints; the continental shelf of Cyprus is very narrow and its slope is relatively steep and as a consequence, the depth of the waters around Cyprus increases abruptly.

6.25.2.3 Catches

6.25.2.3.1 Landings

The official landings of *S. smaris* in GSA 25 by the bottom trawl fishery and the small scale inshore for the period 1986-2008 are given in Figure 6.25.2.3.1.1. The species is mostly exploited by the bottom trawl fishery, with the lowest value in 2005. According to the official landings, this species, together with *B. boops*, are the most abundant commercial species from the demersal resources. The landings of *S. smaris* from artisanal fishery are concentrated in April-June during the spawning season of the species.

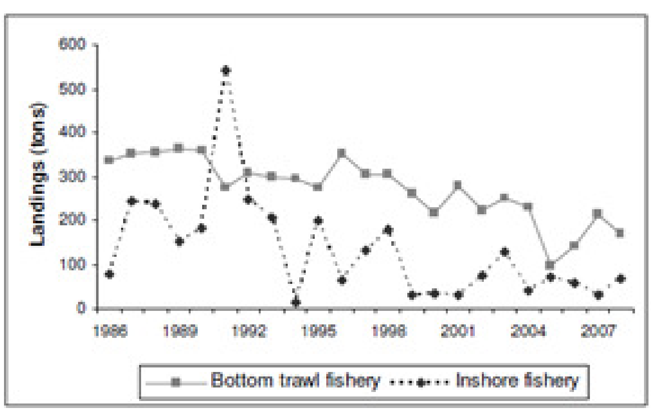


Fig. 6.25.2.3.1.1: Landings and LPUE of *S. smaris* in GSA 25 by fishing gear for the period 1985-2008.

Data on landings and fishing effort are collected by the Department of Fisheries and Marine Research by the following sources:

- Logbooks (for vessels larger than 12 m)
- Landing declarations/inshore reports (from a 15% sample of licensed vessels less than 12m)
- Sampling of vessels at landing sites (for vessels less than 12m)

Landings data provided through the 2011 Official EC Data Call refer to the years 2005-2010. The length distribution of the landings for this period for each fishing gear, as officially submitted, is provided in Figure 6.25.2.3.1.2.

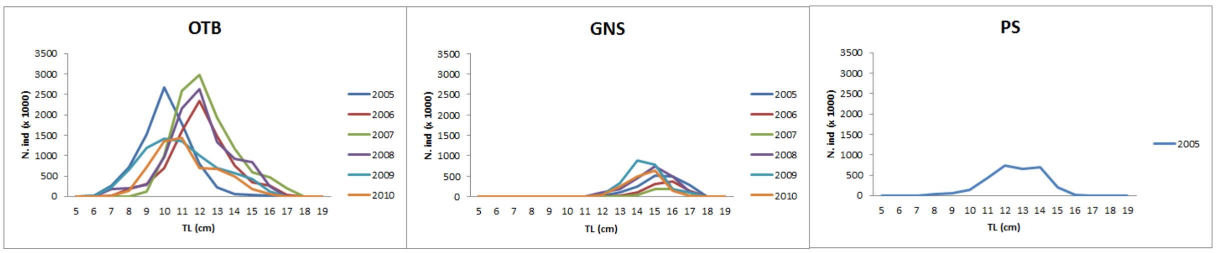


Fig. 6.25.2.3.1.2: Landings length distribution of *S. smaris* in GSA 25 per fishing gear for the years 2005-2010.

6.25.2.3.2 Discards

The estimation of discards of the species involves on-board sampling of bottom otter trawlers; data are collected under the Cyprus National Data Collection Programme since 2006. Discards from the artisanal fishery is considered negligible.

The discard estimates of *S. smaris* in terms of weight for 2010 were less than 2 tons (as provided through the 2011 Official EC Data Call), accounting for about 1% of the total catch of the species. Under the official call, data were also sent on discards length distribution for the years 2006, 2008 and 2009 (fig. 6.25.2.3.2.1).

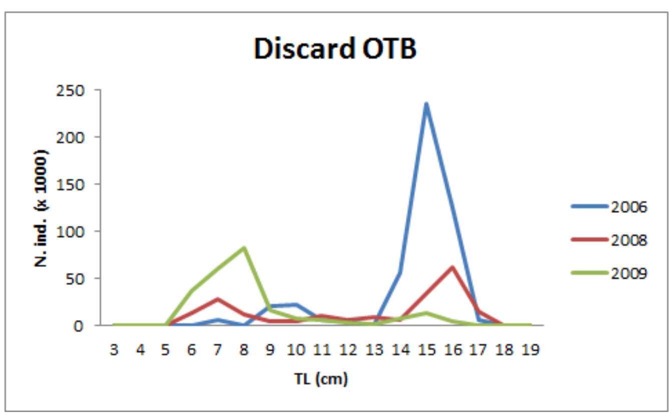


Fig. 6.25.2.3.2.1: Discards length distribution of *S. smaris* in GSA 25 for the years 2006, 2008 and 2009.

6.25.2.4 Fishing effort

Fishing effort data in GSA 25 were provided according to the 2011Official EC Data Call. Table 6.25.2.4.1 lists the reported effort for bottom trawler in GSA 25.

Tab. 6.25.2.4.1 Effort of OTB in GSA 25, 2005-2010.

YEARS	NOMINAL_EFFORT	GT_DAYS_AT_SEA
2005	226727	80282
2006	319660	105209
2007	171287	54750
2008	214413	64773
2009	127599	36481
2010	191945	58074

6.25.3 Scientific surveys

6.25.3.1 Medits

6.25.3.1.1 Methods

Based on the DCR data call, abundance and biomass indices were recalculated. In GSA 25 the following numbers of hauls were reported per depth stratum (s. Tab. 6.25.3.1.1.1).

Tab. 6.25.3.1.1.1. Number of hauls per year and depth stratum in GSA 25, 2005-2010.

Stratum	2005	2006	2007	2008	2009	2010
GSA25_010-050	5	5	5	5	5	5
GSA25_050-100	8	8	8	9	9	9
GSA25_100-200	5	5	5	5	5	5
GSA25_200-500	3	3	3	3	3	3
GSA25_500-800	4	4	4	5	5	5

Data were assigned to strata based upon the shooting position and average depth (between shooting and hauling depth). Few obvious data errors were corrected. Catches by haul were standardized to 60 minutes hauling duration. Hauls noted as valid were used only, including stations with no catches of hake, red mullet or pink shrimp (zero catches are included).

The abundance and biomass indices by GSA were calculated through stratified means (Cochran, 1953; Saville, 1977). This implies weighting of the average values of the individual standardized catches and the variation of each stratum by the respective stratum areas in each GSA:

$$Yst = \Sigma (Yi*Ai) / A$$

$$V(Yst) = \Sigma (Ai^2 * si^2 / ni) / A^2$$

Where:

A=total survey area

Ai=area of the i-th stratum
si=standard deviation of the i-th stratum
ni=number of valid hauls of the i-th stratum
n=number of hauls in the GSA
Yi=mean of the i-th stratum
Yst=stratified mean abundance
V(Yst)=variance of the stratified mean

The variation of the stratified mean is then expressed as the 95 % confidence interval: Confidence interval = Yst ± t(student distribution) * V(Yst) / n

It was noted that while this is a standard approach, the calculation may be biased due to the assumptions over zero catch stations, and hence assumptions over the distribution of data. A normal distribution is often assumed, whereas data may be better described by a delta-distribution, quasi-poisson. Indeed, data may be better modelled using the idea of conditionality and the negative binomial (e.g. O'Brien et al. (2004)).

Length distributions represented an aggregation (sum) of all standardized length frequencies (subsamples raised to standardized haul abundance per hour) over the stations of each stratum. Aggregated length frequencies were then raised to stratum abundance * 100 (because of low numbers in most strata) and finally aggregated (sum) over the strata to the GSA. Given the sheer number of plots generated, these distributions are not presented in this report.

6.25.3.1.2 Geographical distribution patterns

Figure 6.25.3.1.2.1. provides the distribution of sampling hauls of the Medits survey in GSA 25. No analyses on geographical distribution patterns were conducted during EWG 11-12 .

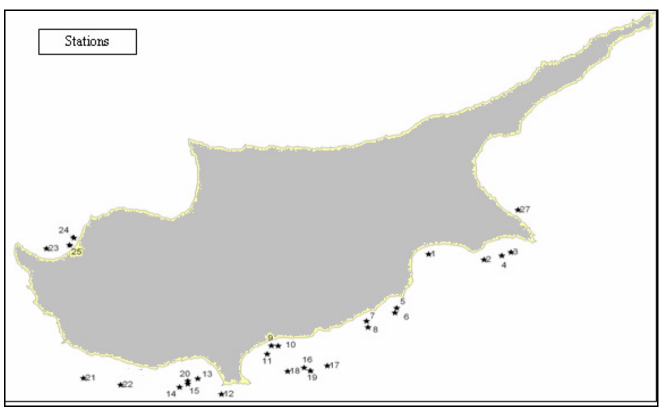


Fig. 6.25.3.1.2.1. Distribution of sampling hauls of the Medits survey in GSA 25.

6.25.3.1.3 Trends in abundance and biomass

Fishery independent information regarding the state of the red mullet in GSA 25 was derived from the international survey Medits.

Figure 6.25.3.1.3.1 displays the estimated trend in picarel abundance and biomass in GSA 25. The estimated abundance and biomass indices reveal general decrease since 2005-2006 and are subject to high variability (uncertainty). This trend seems to be in agreement with the trend in the landings during the same period.

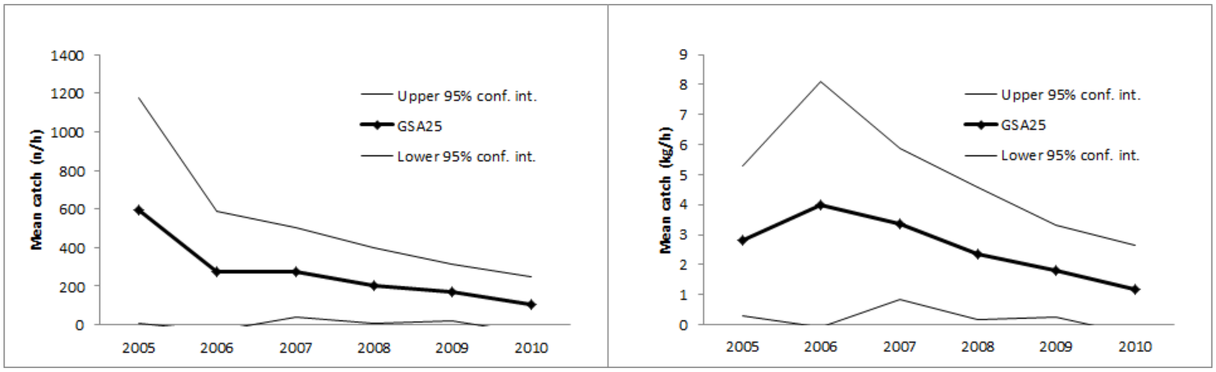


Fig. 6.25.3.1.3.1 Abundance and biomass indices of picarel in GSA 25.

6.25.3.1.4 Trends in abundance by length or age

The following Fig. 6.25.3.1.4.1 displays the stratified abundance indices of GSA 25 in 2005-2010. These size compositions are considered preliminary.

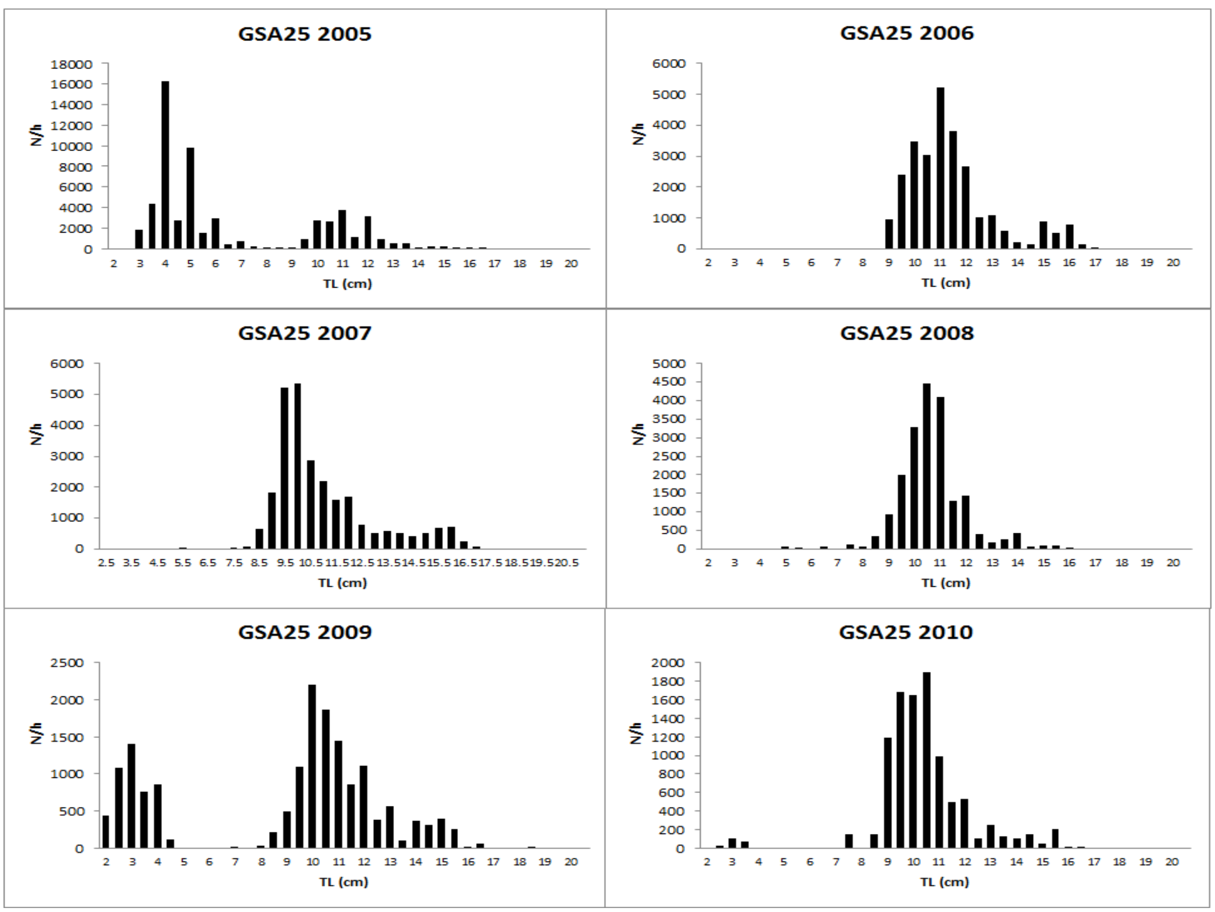


Fig. 6.25.3.1.4.1 Stratified abundance indices by size, 2005-2010.

6.25.3.1.5 Trends in growth

No analyses were conducted during EWG 11-12.

6.25.3.1.6 Trends in maturity

No analyses were conducted during EWG 11-12.

6.25.4 Assessment of historic stock parameters

6.25.4.1 Method 1: Stock Production Model

6.25.4.1.1 Justification

The analysis was performed using the ASPIC.5.34 software (A Stock-Production model Incorporating Covariates) (Prager, 1994, 2005) assuming a Schaefer (1954) model. This program implements a non-equilibrium, continuous-time, observation-error estimator for the dynamic production model (Schnute, 1977; Prager, 1994). The model was used to estimate r (the intrinsic rate of population growth), MSY, the ratios of both current biomass or F to the biomass or F at which MSY can be attained, and q (the catchability coefficient, the proportion of total stock removed by one unit of fishing effort).

6.25.4.1.2 Input parameters

ASPIC based production model has been performed using OTB effort data series provided by official statistics of the Department of Fishery and Marine Research of Ministry of Agriculture, Natural Resources and Environment from 1970 to 2004 (Hadjistephanou, 2003; DFMR, 2003; 2004). For the same period total landing of picarel were provided by the GFCM FishStat database. For the period 2005-2010 OTB effort data and landings statistics were provided by the 2011 official data call. Picarel landings decreased from 2003 to 2010, for the use of the 40 mm mesh size in the trawl net. Moreover in the same period the number of trawler operating in Cypriot waters decreased from 8 to 4. For this reason another run of the ASPIC model using the data series from 1970 to 2003 has been used to estimate the reference points (Long term prediction). Figure 6.25.4.1.2.1 and table 6.25.4.1.2.1 show the input data and parameters to run the model.

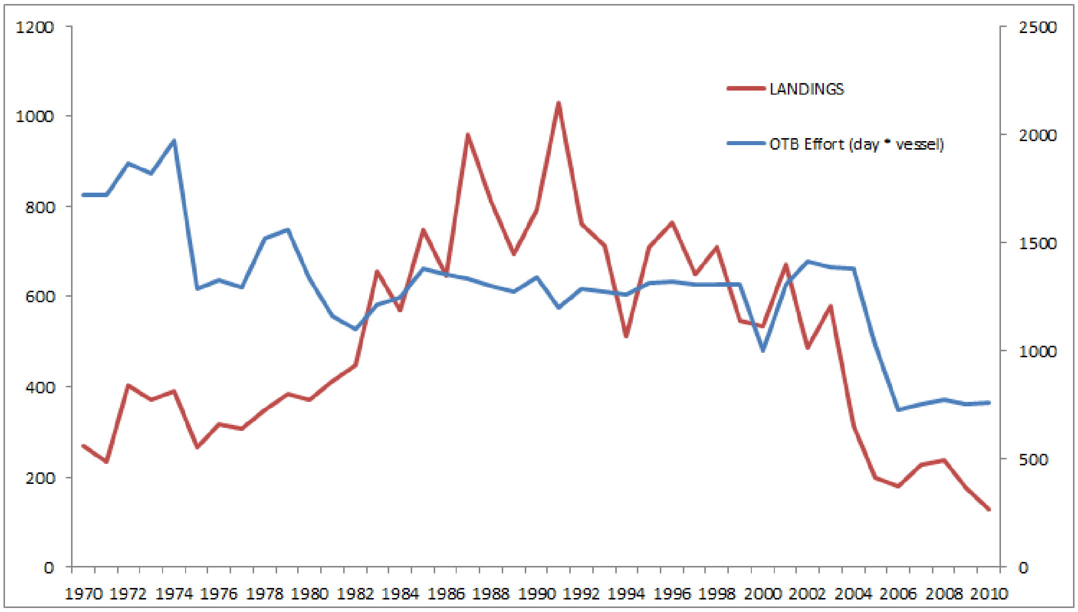


Fig. 6.25.4.1.2.1 – Input data for ASPIC.

Table 6.25.4.1.2.1 Starting input parameters for ASPIC.

Operation of ASPIC: Fit logistic (Schaefer) model by direct optimization.
Number of years analyzed: 41
Number of data series:1
Bounds on MSY (min, max): 5.009E+01 - 1.002E+04
Objective function: Least absolute values
Bounds on K (min, max): 5.009E+02 - 1.002E+05
Relative conv. criterion (simplex): 1.000E-08

6.25.4.1.3 Results

Table 6.25.4.1.3.1. Summarizes the main results of the stock production model.

Tab. 6.25.4.1.3.1 Aspic output main results.

```
GOODNESS-OF-FIT AND WEIGHTING (NON-BOOTSTRAPPED ANALYSIS)
----------------------------------------------------------------------------------------------------
--------------------
                                                     Weighted                Weighted         Current
Inv. var.    R-squared
Loss component number and title                               LAV      N            MSE         weight
weight      in CPUE

Loss(-1)  LAV in yield                              0.000E+00
Loss(0)   Penalty for B1 > K                            0.000E+00      1            N/A    0.000E+00
N/A
Loss(1)   Weighted F (VPA 2+) and Landings             1.068E+01     41            N/A    1.000E+00
N/A       0.396
..............................................................
TOTAL OBJECTIVE FUNCTION:                        1.06784100E+01
Estimated contrast index (ideal = 1.0):                0.2047          C* = (Bmax-Bmin)/K
Estimated nearness index (ideal = 1.0):                0.7934          N* = 1 - |min(B-Bmsy)|/K


MODEL PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
----------------------------------------------------------------------------------------------------
--------------------
Parameter                                                 Estimate     User/pgm guess    2nd guess
Estimated   User guess

B1/K       Starting relative biomass (in 1970)        9.079E-02           5.000E-01    3.284E-01
1            1
MSY        Maximum sustainable yield                   9.682E+02           5.009E+02    4.258E+02
1            1
K          Maximum population size                     9.483E+03           5.009E+03    2.555E+03
1            1
phi        Shape of production curve (Bmsy/K)         0.5000            0.5000            ----
0            1

--------- Catchability Coefficients by Data Series ---------------
q(1)       Effort OTB Cyprus and Landings             2.142E-04           1.552E-02    4.750E-01
1            1


MANAGEMENT and DERIVED PARAMETER ESTIMATES (NON-BOOTSTRAPPED)
----------------------------------------------------------------------------------------------------
--------------------
Parameter                                                Estimate              Logistic formula
General formula

MSY        Maximum sustainable yield                  9.682E+02                             ----
----
Bmsy       Stock biomass giving MSY                   4.741E+03                              K/2
K*n**(1/(1-n))
Fmsy       Fishing mortality rate at MSY              2.042E-01                         MSY/Bmsy
MSY/Bmsy

n          Exponent in production function           2.0000                                ----
----
g          Fletcher's gamma                            4.000E+00                            ----
[n**(n/(n-1))]/[n-1]

B./Bmsy    Ratio: B(2011)/Bmsy                        5.869E-01                             ----
----
F./Fmsy    Ratio: F(2010)/Fmsy                        2.560E-01                             ----
----
Fmsy/F.    Ratio: Fmsy/F(2010)                        3.906E+00                             ----
----

Y.(Fmsy)   Approx. yield available at Fmsy in 2011    5.919E+02                      MSY*B./Bmsy
MSY*B./Bmsy
          ...as proportion of MSY                     6.113E-01                             ----
----
Ye.        Equilibrium yield available in 2011         8.030E+02            4*MSY*(B/K-(B/K)**2)
g*MSY*(B/K-(B/K)**n)
          ...as proportion of MSY                     8.293E-01                             ----
----

--------- Fishing effort rate at MSY in units of each CE or CC series ---------
```

```
fmsy(1)    Effort OTB Cyprus and Landings          9.534E+02                    Fmsy/q( 1)
Fmsy/q( 1)
```

The results of the production model suggest that picarel in the GSA 25 is underexploited (current F_{curr}/F_{MSY}=0.25). Anyway the biomass at sea, after two decades of higher exploitation, is below the B_{msy} (current B_{curr}/B_{MSY}=0.45). Moreover, it is important to highlight, as shown in Fig. 6.25.4.1.3.1, that in the last years the level of biomass shows a general increasing trend while F decreases. La last estimate of F_{curr} is 0.06, while the average biomass at sea is 2,468 tons.

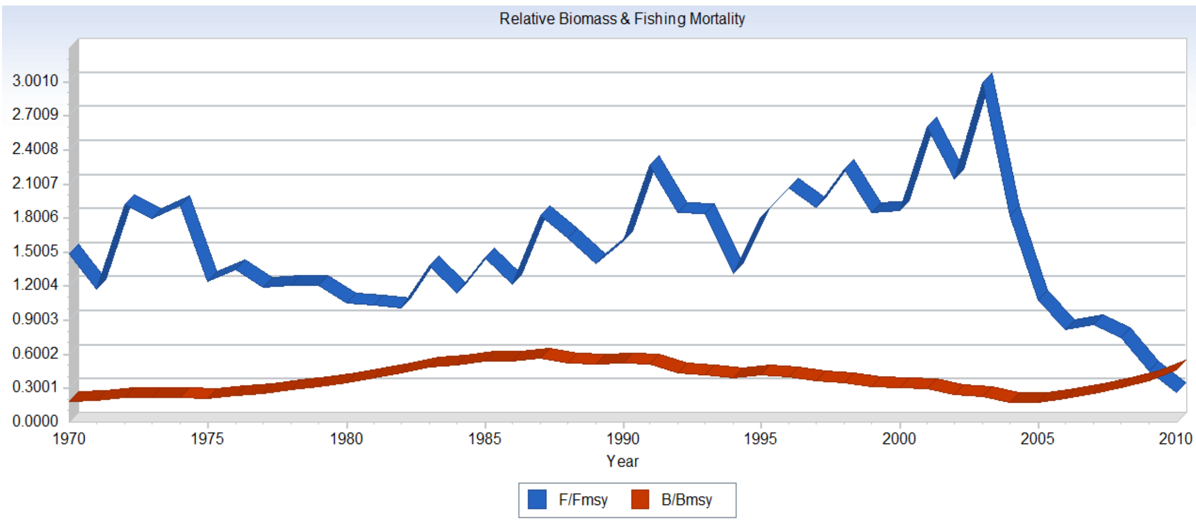


Fig. 6.25.4.1.3.1 Historic trend in estimated fishing mortality as F/FMSY ratio and biomass as B/BMSY ratio.

Data of observed yield of OTB in GSA25 have shown a good agreement with the predicted yield of the model until 2007.

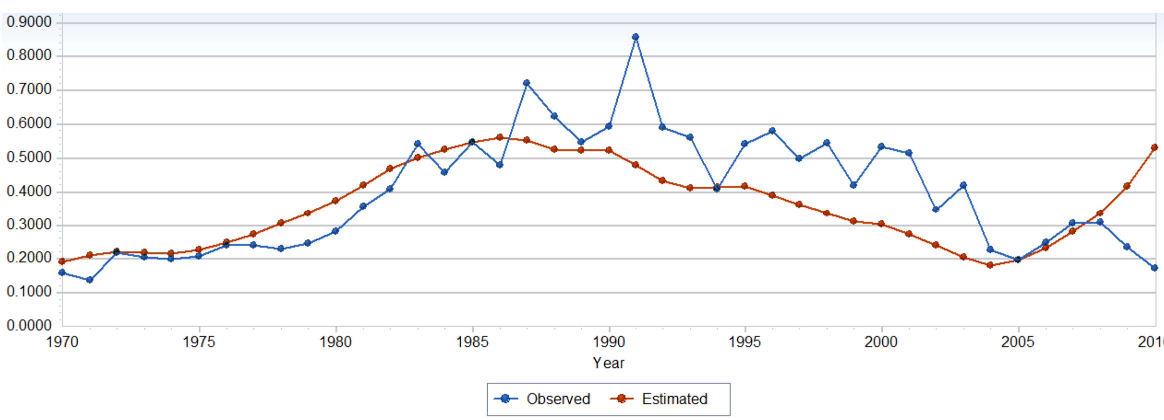


Fig. 6.25.4.1.3.2 Landings data of observed and estimated yield of OTB.

6.25.4.2 Method 2: XSA

6.25.4.2.1 Justification

Considering the variability in the recruitment, the assessment is based on non-equilibrium method. VPA Lowestoft software suite (Darby and Flatman 1994) was used and XSA was the assessment method. A separable VPA (Pope and Sheperd, 1982) was also run as exploratory analysis for this stock.

6.25.4.2.2 Input parameters

For the XSA, catch at age data series of the period 2005-2010, provided by 2011 Official EC Data Call were used.

Maturity at age, Weight-Length relationships, growth parameters (utilised in the slicing of Medits data) were provided in the framework of the 2010 Official EC Data Call.

Tuning data were provided by Medits surveys, carried out in fall for the years 2005-2010 and LPUE of otter trawl commercial fleet of Cyprus.

A vector of natural mortality rate at age was estimated using the PRODBIOM spreadsheet (Abella *et al.*, 1997).

Tab. 6.25.4.2.2.1 Input parameters.

Catch at age in numbers (x 1000)					
	0	1	2	3	4+
2005	2029	4593	3221	1767	1040
2006	448	1938	3793	2155	1174
2007	162	2581	5046	2567	1111
2008	664	2616	4477	2852	1404
2009	1765	2769	2522	2261	924
2010	662	2441	2085	1629	546

Survey indexes (N/h)							
	0	1	2	3	4	5	6+
2005	22	18	5	10	1.4	0.46	0.06
2006	0.1	0.1	8.5	13.7	2.2	1.2	1.3
2007	0.1	0.07	14.7	7.2	1.7	1.2	1.6
2008	0.1	0.2	9.1	9	0.9	0.25	0.07
2009	4.6	0.1	5.1	4.5	1.1	0.8	0.3
2010	0.2	0.15	6	3	0.5	0.3	0.16

OTB LPUE (N/vessel*day)							
	0	1	2	3	4	5	6+
2005	0.005634	0.011924	0.004971	0.000635	0.000080	0.000018	0.000001

2006	0.001833	0.007925	0.015244	0.007490	0.001976	0.000541	0.000084
2007	0.000640	0.010194	0.019819	0.009474	0.002283	0.000928	0.000298
2008	0.002555	0.010026	0.015938	0.007348	0.001990	0.000433	0.000048
2009	0.006937	0.010869	0.008013	0.004048	0.001049	0.000204	0.000008
2010	0.002594	0.009547	0.006850	0.003055	0.000542	0.000088	0.000003

Mean weight in catch and stock					
	0	1	2	3	4+
2005	0.007	0.012	0.025	0.033	0.04
2006	0.006	0.01	0.025	0.029	0.0395
2007	0.009	0.011	0.027	0.035	0.0435
2008	0.004	0.01	0.024	0.03	0.035
2009	0.005	0.01	0.023	0.029	0.035
2010	0.006	0.012	0.026	0.03	0.037

Growth parameters			
PERIOD	L_∞	k	t_0
2005-2010	19.57 cm	0.2678 y^{-1}	-2.084 y

Length-weight relationships		
PERIOD	a	b
2005-2009	0.00679	3.119

Maturity at Age					
PERIOD	0	1	2	3	4+
2005-2009	0.79	0.85	0.90	0.85	0.97

Natural mortality (M)					
PERIOD	0	1	2	3	4+
2005-2009	0.38	0.12	0.08	0.08	0.08

6.25.4.2.3 Results

A separable VPA was run as exploratory analysis for both sets of data. Log catchability residual plots were produced (Fig. 6.25.4.2.3.1). Conflicts between ages seems to appear for ages 0/1 and 2/3. Anyway the EWG 11-12 decided to continue the analysis with the same set of data.

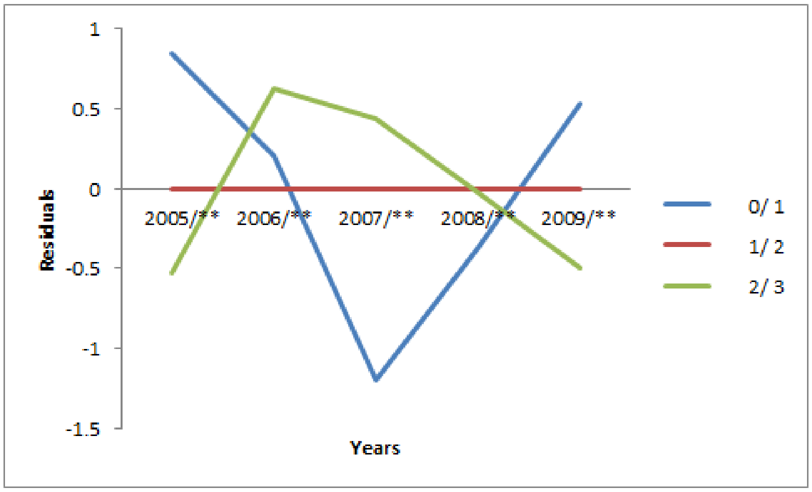


Fig. Fig. 6.25.4.2.3.1 Residuals of log catchabilities.

Then XSA runs were made using the following settings:

- F_{bar} 0-3.
- Catchability dependent on stock size for ages < 1.
- Catchability independent of age for ages >= 1
- S.E. of the mean to which the estimates are shrunk = 0.10
- Minimum S.E. for population estimates derived from each fleet = 0.30

XSA Diagnostics form of residuals by survey and CPUE data are shown in the figure Fig. 6.25.4.2.3.2.

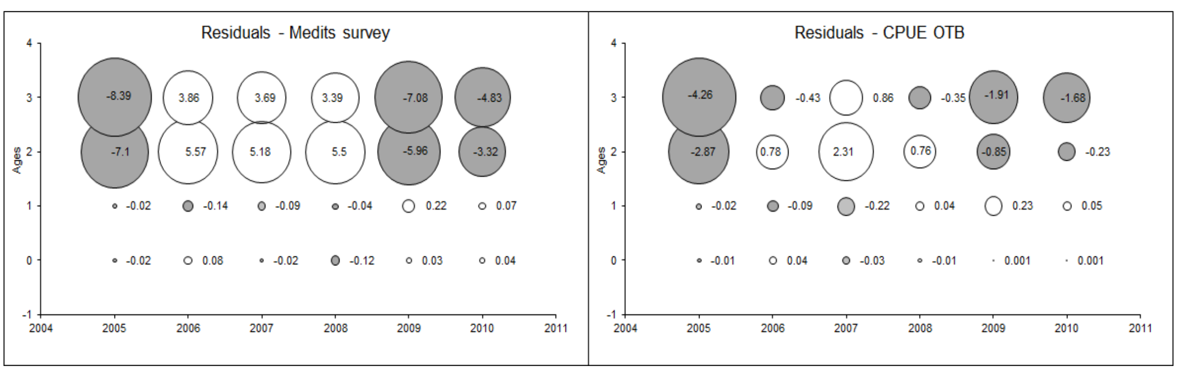


Fig. 6.25.4.2.3.2 Log transformed catchability residuals by survey and CPUE from commercial OTB.

In both cases no trends in the residuals were observed.

The figures Fig. 6.25.4.2.3.3 present the main results from the XSA run: fishing mortality, relative F at age, total biomass, spawning stock biomass (SSB), recruitment.

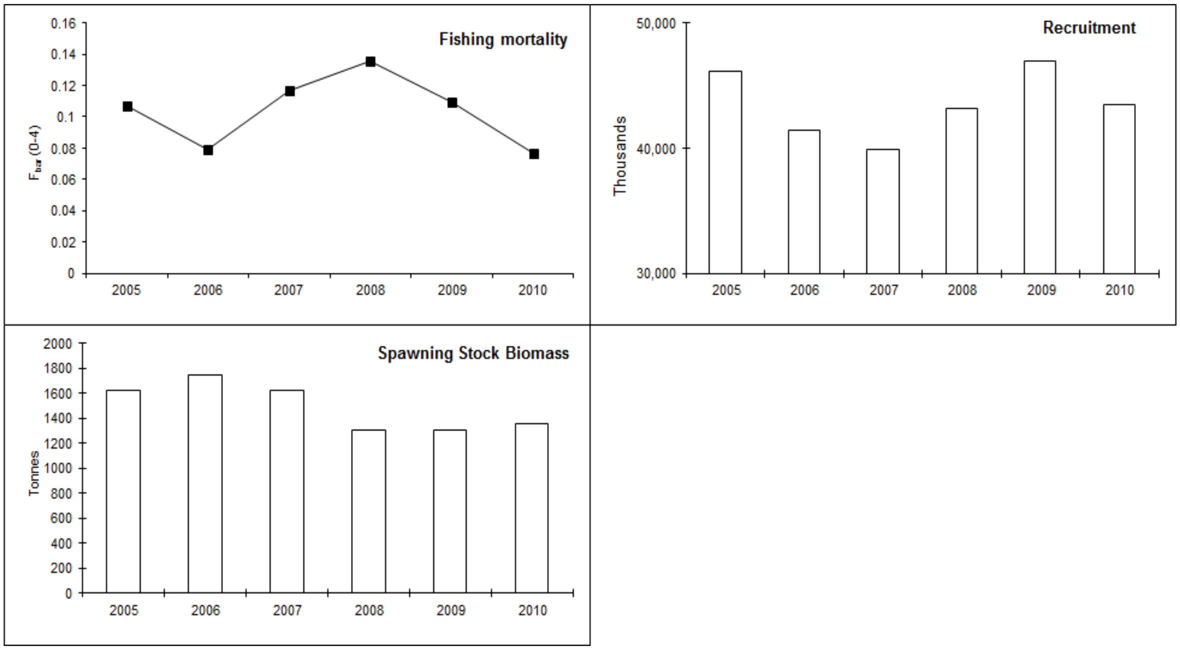


Fig. 6.25.4.2.3.3 Final assessment results first XSA run.

State of exploitation: fishing mortality oscillated around 0.1 for the entire period. The most recent estimate of fishing mortality (F_{0-3}) is 0.08.

State of the juveniles (recruits): recruitment varied without any trend in the years 2005-2010, reaching a minimum in 2007, and increasing in 2010

State of the adult biomass: the SSB seemed to be stable around 1,600 tons in the period 2005-2007, while decreased to around 1,200 tons in the following period. In 2010 the SSB and the total biomass at sea were respectively 1,351 and 1,624 tons.

6.25.5 *Short term prediction*

Will be accomplished during the follow-up meeting during 16-20 January 2011.

6.25.6 *Long term prediction*

6.25.6.1 Justification

Considering the changes in the landing and effort data series, respectively due to the adoption of the 40 mm mesh size and the reduction in the number of trawler from 8 to 4, a second run of ASPIC with a shorter data series (1970-2003), has been carried out in order to better estimate target management reference points. Moreover an Yield per recruit analysis was performed by VIT model using 2010 GNS and OTB landings data.

6.25.6.2 Input parameters

Same input parameters used for the first run of ASPIC and XSA analysis (using a terminal F = 0.08) were employed respectively for the second run of ASPIC and the yield per recruit analyses.

6.25.6.3 Results

Table 6.25.6.3.1 lists the management reference points. The figure 6.25.6.3.1 shows the results of the yield per recruit analysis.

Table 6.25.6.3.1 – reference points.

Maximum sustainable yield (MSY; t)	829.8
Stock biomass giving MSY (B_{MSY}; t)	2,637
Fishing mortality rate at MSY (F_{MSY})	0.314
$F_{0.1}$ from Y/R	0.25

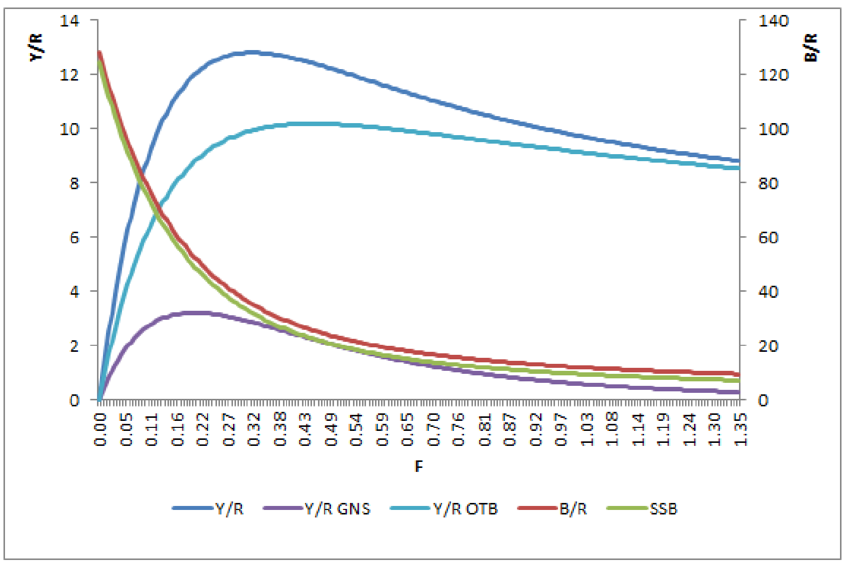


Fig. 6.25.6.3.1. Yield per recruit results for *S. smaris* in GSA25.

Considering the estimates of F_{curr} from both approaches, it can be concluded that the stock is underexploited. The biomass at sea showed values substantial lower than the reference level only in the estimate made by the XSA.

6.25.7 Data quality

Catch at age data showed different exploitation patterns in the years, perhaps linked with different approaches in otolith reading.

Differences in the comparison between total landing data submitted in the previous official DCF data and 2011 official DCF data were observed only in 2005 and 2006 of 18%.

The comparison between total landings and landings reconstructed as the sum of the landings at age evidenced differences from 0.03 to 11% of the total landings by gear and year.

6.25.8 Scientific advice

6.25.8.1 Short term considerations

6.25.8.1.1 State of the spawning stock size

In the absence of proposed or agreed precautionary refernce points stecf EWG 11-12 is unable to fully evaluate the status of the spawning stock size. In the current stock assessment no trend in the spawning stock biomass is evident.

6.25.8.1.2 State of recruitment

STECF EWG 11-12 is unable to provide any scientific advice of the state of the recruitment as no trend in recruitment is evident.

6.25.8.1.3 State of exploitation

STECF EWG 11-12 proposes F0.1 = 0.314 (Fmsy proxy) as limit management reference point consistent with high long term yields and low risk of fisheries collapse. In relation to the estimated values of current F (0.06 and 0.08), EWG 11-12 classifies the stock's exploitation status as sustainable.

7 ToR F Quality and completeness of the official Mediterranean DCF data call

The meeting participants were informed about data quality of the Member State's data submissions with regard to the DCF 2011 data call issued by DG Mare on 3 August 2011 with a deadline by 2 September 2011. The presentation by JRC (Hans-Joachim Rätz) covered the dates of data submissions and the detailed data of fisheries specific landings, discards and fishing effort parameters. JRC had reformatted the data submitted in 2010 as reference data base into the new data format of the 2011 DCF data call. This allowed a detailed evaluation of revisions in the data in 2011 as compared to those submitted in 2010. The participants took duly notes of the data deficiencies and commented in the various stock and fisheries assessments of the preceeding sections.

8 ToR G Empirical biologic indicators and methodologies for stock assessments lacking standard data requirements

The socalled SEINE method, previously recommended during STECF SGMED 10-01, was tested by estimating total mortality (Z) for several species historically not assessed in GSA 09 using a mean length approach derived by Gedamke & Hoenig (2006), which does not require equilibrium conditions. EWG 11-20 concludes that the SEINE method is a rather simple, less data demanding method that in theory could be used to derive an estimate of Z for any species with length data from survey or from commercial catches. Having a minimal data requirement, it has also the potential for a widespread use in data poor situation as it is the case for several species exploited in the Mediterranean Sea. However, it is also clear that its use is not suitable for those species that are not representatively sampled. In general, EWG 11-12 concludes that for small sized species where both adults and juveniles are effectively sampled by the gear, the SEINE method has the potential to provide robust estimate of Z and detect eventual temporal changes in mortality rates.

9 ToR H Computer program R-scripts to evaluate MEDITS and other CPUE data series

EWG 11-12 was requested to further develop and test the developed R scripts to facilitate the evaluation of both survey and commercial data series. In the absence of appropriate expertise EWG 11-12 was unable to address the task to further develop and test the developed R scripts to facilitate the evaluation of both survey and commercial data series, and EWG 11-12 recommends to defer the task to future meetings.

The R Script first developed for *STECF SGMED 10-01*, has reached Version 5 thanks to several new implementations and adjustment to adapt it to the latest version of the MEDITS database. Both the *db.connect.r* and the deterministic length slicing function for MEDITS survey data have been refined and made more efficient. An entirely new function implemented during EWG 11-12 part 2 is a statistical age slicing for landings data, this is designed to query the landing from the DCF database, import the data, perform slicing and return numbers at age plus catch curves. Now the R script can perform a deterministic slicing on MEDITS data maintaining the spatial disaggregation level of hauls or perform statistical slicing on DCF landings numbers at length or potentially with little adjustment on aggregated MEDITS data.

EWG 11-12 recommends further improvement of the R-scripts during the follow-up meetings but also some training for users so that the scripts will be of easier use to EWG participants.

9.1 Statistical Slicing

The new statistical slicing method is more sophisticated than the one previously implemented. This method assumes that the distribution of numbers at length is composed of a mixture of length frequency distributions. The statistical method estimates the parameters of these distributions. A range of options are available including different distribution shapes and the possibility of fixing some of the parameters. The fitting is performed using the R *mixdist* package. A description of the package, the method and the script can be found in Annex II .

The statistical method is very flexible and offers a more sophisticated method for age slicing data. As well as estimating the mean length at age, it estimates the distribution of lengths at age. However, because of its flexibility great care must be taken when setting the constraints, initial parameters and the choice of distribution. Additionally, the method ideally requires data in which modes are clearly seen. As the method using optimisation routines there is no guarantee that the method will work. Because of this it is suggested that several fits with different options are carried out to decide which one is the most appropriate.

In contrast, the deterministic knife edge method is simple and can work with any amount of data. Due to the simplicity in using the method it is suggested that it is always used and the results compared to the statistical method. It is possible to perform a simple Monte Carlo analysis on the knife edge method to estimate the variance in the sliced results.

The comparison of two XSAs with the different slicing methods revealed only some differences between the assessment results, particularly in the estimate of SSB. It is suspected that when there are distinct modes in the catch distribution data this difference will become more pronounced. Overall the statistical method is very promising and further investigation of its application is recommended. However, it is still worth including the simpler knife edge method as a comparative 'base case'.

It is recommended that further discussion shall be undertaken on the potential adoption of the statistical slicing as a standard routing for EWG assessments. Such additional capability, pending further testing, if adopted as a standard tool for data processing can result in significant efficiency improvement and better quality slicing and methodology.

9.2 Comparison R script and ATRIS

Through the FAO-AdriaMed Project the AdriaMed Trawl Survey Information System(ATrIS) has been developed as a simple and common tool to store and perform basic processing of the data collected by the countries participating in the AdriaMed demersal trawl survey. The objectives of the ATrIS are to facilitate storage, retrieval, updating, analysis and manipulation of trawl surveys data including spatially referenced information; to build capacity to create, use and maintain a trawl survey database in each country; to facilitate sharing of trawl surveys data within and between countries in the Adriatic Sea. The ATrIS consists of 2 parts: i) a database (Access) for storing the spatial and monitoring data for each survey, with basic querying, updating and reporting capabilities. and ii) a spatial database that includes data stored directly within GIS (i.e. ArcView). Key concepts upon which ATrIS has been developed are regional management structure, database consistency management methods, capacity building for data analysis and GIS application and enhanced reporting capacity.

The R script was developed by Bartolino, Osio and Scott in 2009 in the SGMED context is a routine to query MEDITS ACCESS DB, but can be adapted to PostgresSQL or other DB formats. It was designed to facilitate the work of scientist to extract, explore, plot, map and perform statistics on the MEDITS data. In the most recent version it can query DCF database for landings at length and performs a new type of statistical ages slicing. Conceptually the script provides the essential data manipulation routines necessary to fit statistical models (like GLM, GAM, GLMM or spatial statistics) in an open source platform with unlimited extensibility. This means that a wide range of models and packages can be used including stock assessment models (in FLR). The R script can be a unique environment to perform complete stock assessment starting from querying databases to fitting stock assessment models (as in FLR), with the additional advantage of producing maps of various types and being completely free and more and more an international standard. The only drawback is that it requires good programming skills to use or modify the routines and advanced statistical skills to fit certain types of models.

The main difference between the two programs is that ATRIS is a database structure with useful routines relying on non open access software (MS ACCESS and ARCView/ARCGis) while the R script has no database functions, other than performing queries, but is a powerful platform in which several analysis can be performed. If ATRIS is commonly used in many fisheries contexts, it could be very useful to link it with the R routine to extend the ATRIS statistical capabilities while maintaining an existing and routinely adopted database structure.

10 ToR I Frameworks to deliver management advice for multi-species/stocks fisheries

10.1 Introduction

EWG 11-12 noted that the great majority of Mediterranean stocks are exploited by multi-species (mixed) fisheries, particularly the near bottom and bottom dwelling species due to their coexistence in diverse communities and the poor selectivity of many gears used. Still, the variety of exploited stocks in mixed fisheries requires specific conservation needs as defined by the Marine Strategy Framework Directive (EU 2008) based on the specific ecological role and stock status (Piet et al., 2010). It is further noted, that the selection of the various mixed fisheries involved in the exploitation of certain stocks potentially varies with the areas, gears and the fishing strategies. It is argued that the mixed fisheries are best managed by fishing effort, if they deploy trawled (active) gears. This can be done by settings of maximum allowable effort (TAE) in units of days at sea or the product of kilo Watt times days at sea to account for boat specific fishing power. The applicability of such effort measures regarding passive demersal gears has still to be proven. Fishing grounds with high stratification, e.g. along continental shelves, may force certain stocks or parts of them to occur highly aggregated and thus make pure effort measures ineffective to control fishing mortality, like in the example of pelagic fisheries. However, catch figures estimated and set consistently with effort constraints (TAE) will help to communicate foreseen constraints in fishing possibilities to the involved stakeholders.

10.2 Description of the stochastic medium term forecast model for mixed fisheries presented by H.-J. Rätz

10.2.1 Introduction

Hans-Joachim Rätz introduced a stochastic medium term forecast model for mixed fisheries (maximum 10 stocks, 10 fisheries) which provides quantitative conclusions on future catch and biomass trends under various management scenarios over medium term (10 years) (Rätz et al. 2007). The model is age specific and thus capable to consider fisheries specific exploitation patterns and temporal changes of them. It is formulated in VISUAL BASIC using EXCEL spreadsheets as in- and output.

The STECF EWG 11-12 undertook a detailed exploratory analysis of the mixed demersal fisheries in GSA 9 based on fisheries definition consistent with the DCF definitions and the data received through the DCF data call in 2010. However, as the knowledge of the fishery specific catch profiles and productivity of the stocks are largely incomplete as well as important stock specific management goals remain unaccepted by the relevant management frameworks, **the analyses presented shall be exclusively used and interpreted for illustrative purposes of various fisheries management scenarios and in no way they are considered to form the basis of fisheries management decisions.** The analyses undertaken are meant to guide the management with potential options regarding the design of multiannual management plans towards sustainable fisheries. Four fisheries are defined being engaged in the catch of seven stocks. **Noticeably the fisheries specific weighing presented in this description has been amended in comparison with the method presented and used during STECF EWG 11-05. Furthermore, the present method estimates the stock specific productivity applying an average recruitment over recent years rather than a Ricker function quantifying a feedback on future recruitment by the stock size.**

The parameters used and proposed changed fisheries weighing procedure is described in the following section and believed to better reflect the management requirements in mixed fisheries. Consistent with the GFCM decision in 2009 (Resolution GFCM/33/2009/1 on the Management of demersal fisheries in the

GFCM Area) regarding an annual reduction in fishing effort by 10% for all Mediterranean fisheries, the simulations of management plans consider an annual reduction of fishing mortality by 10%. In order to evaluate the potential to realize Fmsy targets for all stocks analysed, one simulation considers an annual reduction in fishing mortality by 30%.

10.2.2 Model description and settings

The model is formulated as a MICROSOFT EXCEL workbook with embedded macros, using VISUAL BASIC for applications as program language. The model is age specific for both landed and discarded portions of the catch. For each stock and fishery the requested inputs have to be specified in yellow shaded cells. 100 iterations are performed in order to quantify the variation of the model results.

The major underlying dynamic concept is defined as

$$N_{y+1,a+1} = N_{y,a} \exp(-(M_{y,a} + F_{y,a})) \qquad (1),$$

where N denotes stock size in numbers in given year y at age a, M equals natural mortality and F fishing mortality Beverton and Holt (1957).

The most important stock productivity parameter is the recruitment to the stock

$$R = \alpha\, S \exp(-\beta\, S) \qquad (2),$$

where R denotes the recruitment to the stock, S the parental stock size with α and β as stock specific parameters (Ricker, 1975).

Due to shortage of the time series and the consistent poor understanding of the spawning stock recruitment relationship, the recruitment estimates are based on a recent average of the past few years available. For the projection period of 10 years such annual recruitment is subject to a coefficient of random variation of 50%.

Finally, the catch equation links the observed catches taken from a given stock with the stock size and the two components of mortality, i.e. the natural M and the fishing mortality F as

$$C_{y,a} = F_{y,a}\, N_{y,a}\, ((1-\exp(-(F_{y,a} + M_{y,a}))) / (F_{y,a} + M_{y,a})) \qquad (3)$$

where C denotes catch in numbers in a given year y at age a (Beverton and Holt, 1957).

Stock specific production parameters (weight at age, recruitment, fishing mortality) required and the limit reference management levels have to be defined. The matrix of actual contributions in terms of fishing mortalities (partial fishing mortality F) by stock and each fishery has to be given. The fisheries are defined as harvest activities which share certain stocks in the same management areas. The more complete the catch composition is covered, the more representative the results are.

The application of the program starts with the definition of the mixed fisheries over the significant stocks and the significant fisheries to the overall catch, each set as a maximum of 10 (start page). Then the start year of the medium term simulation shall be defined.

In order to allow for a simulation of evolving fisheries in an unexploited ecosystem, the program allows for a reduction of the defined selectivity patterns by 90 %, treating the defined selection pattern as relative. As this is not the normal situation, it is recommended to keep the default setting as “n” (=no).

The following options allow managing the future catch possibilities under two different options. Either all stocks’ Ftargets shall simultaneously constrain the fishery or only one (highest) Ftarget decisive. Under the first option as “a” (=all), there would be no overquota catches for none of the stocks in the mixed fisheries allowed. While all stock specific conservation needs are respected, the majority of the fishing possibilities from individual stocks would not be completely taken. Under the second option as “h” (=high), the fishing activities would only be ceased after the fishing possibilities of one individual stock has been accomplished. Frequently, this one stock is the most productive on and thus implies high overquota catches (discards in case of landing restrictions) in access of the remaining stock specific conservation needs.

The easiest approach to deal with mixed fisheries management is treat all defined fisheries proportionally, their F impact and resulting catch possibilities would change proportionally. Another way is to treat the fisheries disproportionally, e.g. if they constitute to overfishing of a stock or not. This is done with the following two parameter settings. Now, the first of the two parameters allows to quantify the threshold at which fisheries are subject to specific measures through the ration F/Ftar >= X (input). The lower the value, the more of the less contributing fisheries will be considered in the mixed fisheries scenarios, while the fisheries below the defined ratio will not be subject to such specific measures. It is recommended to set this parameter to 0.05, in order to consider in the mixed fisheries framework which contribute to more than 5% of any of the overexploited stocks in the actual year.

The second parameter specifies a maximum relative annual change in partial Fs for all species reflecting the underlying pre-agreed management plan across all species. Is the maximum annual change of fisheries' partial F factor set at 0, there is no fisheries specific management applied (default) and all fisheries considered in the analyses will be subject to the same F-adaption. If the parameter exceeds 0 a fisheries specific factor on fishing mortality will be applied as follows: All species specific fishing mortalities of fisheries not contributing to any overfishing of any stocks will be increased by the relative value set. Fisheries identified to contribute to any overfishing of any stock will be downgraded by this value being applied to all relevant exploitation patterns. Unless other fisheries specific management intentions being applied, the factor will inevitably force the mixed fisheries to a more equal effect of all fisheries on all stocks. Actually, high values of this parameter imply an immediate move to such balanced situation (after one or few years) and such plan may imply radical consequences to the individual fisheries concerned. As a more smoothed solution may be more desirable and explored, the parameter may be set for example at 0.1, i.e. the annual maximum change in fisheries specific F (fishing patterns) would be ± 10% for any of the fisheries included in the analysis. In this case, the fisheries disproportional specific factor to the F will be applied, e.g. by favoring fisheries avoiding overfished stocks or selecting less stocks from the ecosystem (Rätz *et al*., 2007). This fishery specific weighing method is easy comprehendible and less complex as compared with the method applied during the STECF EWG 11-05 meeting. The new weighing procedure has been developed to better reflect the policy to avoid overfishing in all stocks simultaneously and to propose a consistent management option.

Following the definition of the above described mixed fisheries management scheme (harvest control rules) on the start page of the EXCEL work book, the stock specific parameters have to be defined on a stock by stock level. The structure of the stock specific sheets "stock1inp" to "stock10inp" is identical. First of all, the range of age groups of data (youngest and oldest) and the range of age groups to estimate the reference F is to be defined. Then for each age group the weight at age in the stock, proportion mature and natural mortality M (10 years historic averages) has to be defined, as well as a recent the most recent stock size in numbers (thousands, 1 January in the start year of the simulation). Then the specific Ricker's stock recruitment parameters a and k have to be quantified in order to allow the program to stochastically generate future recruitment. The 5 % quantile recruitment (minimum) is a recruitment threshold which limits the lowest recruitment possible. The recruitment relative variation CV is the coefficient of variation observed in the time series of recruits estimated, which defines the variation of the generated recruitment. The Bpa (t) Bmsy trigger is a reference value to evaluate the stock status, usually a level without impeded recruitment. The parameter F target management plan defines the upper limit (target) of sustainable exploitation, defined as Fmsy or its proxy. The relative parameter 'Rel. max. annual change Fref' limits the annual variation of F to reach the management reference point. The relative 'parameter Rel. max. annual change TAC' stipulates the maximum change in total allowable landings. This option is inactive in the present workbook, as the option implies conflict with the maximum annual change in F in a multispecies context.

For each age group and fishery the partial fishing mortality F on landings, the mean weight of the landings, the partial fishing mortality F on discards and the mean weight of the landings has to be provided on the right hand side of each of the stock specific input pages. For numerical reasons it is necessary that each of the stock is harvested by each of the fisheries defined. It is therefore foreseen in the program to define very low partial fishing mortalities (F=0.001) for fisheries which do not at all contribute to the catch neither as landings nor as discards.

For most of the parameters it is possible to define a random variation by a coefficient of variation (CV) and for some of the parameters there can be defined a relative level of bias from the average value, negative or positive, the default is no bias =0.

The model used provides iterations (100) of medium term stochastic forecasts of fisheries and age specific stock size, landings, discards and fishing mortalities. The model provides median trends of important stock and fisheries specific trends and tables listing the relevant values.

10.2.2.1 Advice to the user

The setup of the management scheme and the demand of the parameters to quantitatively describe mixed fisheries are particularly complex. The user is advised to consider the following hints:

- The model presented is very sensitive to many of the parameters requested, in particular to those quantifying stock status (stock size in the starting year), stock productivity as defined by mortality (fishing mortality F and natural mortality M), and recruitment as well as the reference values to them.

- Identify the specific fisheries with representative data, i.e. for each of the species/stock all fisheries' specific landings and discards shall be given.

- The sum of the fisheries' specific fishing mortalities should be in agreement with the estimated total fishing in the population. Fishing mortality which cannot be attributed to an individual fishery could be assigned a lump group of "others". However, this lump group shall not represent significant mortality rates as this could indicate biased results.

- Unless you want to analyse only a single mixed fishery, exclude fisheries not relevant in the mixed fisheries system, i.e. not technically interlinked through the catch of at least one species/stock which is caught by another fishery. Although the program is able to deal with unlinked fisheries, their exclusion will reduce the complexity and ease the interpretation of the results.

10.2.2.2 Data used and design of scenarios

Table 10.2.2.2.1 lists important stock specific parameters being used in the simulations. They are stock size in numbers at age in 2011 of the seven stocks considered and the estimated fishing mortalities at age in 2010. The listed estimated fishing mortalities are applied in 2011 as a status quo assumption for that year.

Table 10.2.2.2.1 Stock size in numbers in 2011 and fishing mortalities at age in 2010 as adopted from the above given stock specific assessments. The stocks are European hake (HKE), pink shrimp (DPS), Norway lobster (NEP), red mullet (MUT), blue and red shrimp (ARA), giant red shrimp (ARS), and black mouth cat shark (GAM).

GSA 9	HKE	HKE	DPS	DPS	NEP	NEP	MUT	MUT	ARA	ARA	ARS	ARS	GAM	GAM
Age (years)	N 2011 (1000)	F 2010	N 2011 (1000)	F 2010	N 2011 (1000)	F 2010	N 2011 (1000)	F 2010	N 2011 (1000)	F 2010	N 2011 (1000)	F 2010	N 2011 (1000)	F 2010
0	120000	0.422	200000	0.16	20000	0.008	700000	0.278					4000	0.006
1	11590	2.225	72482	0.31	13538	0.106	88527	1.579	30000	0.034	15000	0.016	3812	0.101
2	510	1.653	47344	0.38	7738	0.416	4371	0.952	12938	0.188	3892	0.45	1980	0.675
3	121	2.133	4598	0.24	2981	0.278	753	0.809	6943	0.595	1181	1.007	658	0.4
4	13	2.133	1380	0.24	1608	0.314	142	0.438	2268	0.98	225	1.103	429	0.133
5					775	0.365	56	0.402	517	1.004	48	2.091	257	0.269
6					353	0.321			136	0.783	3	0.543	201	0.041
7					175	0.113			49	0.548	2	0.796	117	0.154
8					115	0.12					0	0.505	77	0.408
9													29	0.525

The technical interactions of four demersal fisheries in GSA 9 are described in the Table 10.2.2.2.2 The technical interactions of the four fisheries regarding the exploitation of the four stocks are quantitatively expressed in terms partial fishing mortalities. The dominant otter trawl fishery 'OTB' is the major contributor to the exploitation of 5 out of the 7 stocks, namely HKE, DPS, NEP, MUT, and GAM. Gillnets (GNS) are targeting HKE, while GRT's contribution to the exploitation of HKE and MUT are minor. The deep otter trawl fishery OTB does target the two shrimp stocks of ARA and ARS.

All values adopted were estimated adopted from the assessment sections in the present reportIt becomes clear that 6 of the stocks are overfished, with HKE being the heaviest case. Only the DPS is considered to be sustainably exploited, as its fishing mortality is below the limit reference Fmsy. In summary, all 4 demersal fisheries considered contribute to the harvest of the overexploited stocks, with the 'GTR' having the lowest impact regarding fishing pressure.

Due to shortage of data series the dynamics of the involved stocks are poorly known, in particular the recruitment variation. Instead of using the proposed Ricker function, a standard recruitment (short term mean) with a CV of 0.5 was applied as stochastic approach to generate the future recruitment.

Table 10.2.2.2.2 Technical interactions between four demersal fisheries and seven stocks jointly exploited. The stocks are defined in Table 10.2.2.2.1. Average partial fishing mortalities (age groups considered in brackets) are listed with the estimated total F in 2010 and in relation to the biological limit reference point Fmsy. The stocks' exploitation status and fisheries status are given.

GSA 9								Contribution
Fishery	HKE (1-4)	DPS (1-4)	NEP (2-7)	MUT (1-4)	ARA (2-6)	ARS (2-6)	GAM (2-9)	to overfishing
OTB	1.008	0.171	0.301	0.918	0.021	0.000	0.320	yes
GNS	1.024	0.000	0.000	0.000	0.000	0.000	0.000	yes
GRT	0.004	0.000	0.000	0.027	0.000	0.000	0.000	yes
OTB deep	0.000	0.121	0.000	0.037	0.689	1.034	0.000	yes
F 2010	2.036	0.292	0.301	0.982	0.710	1.034	0.320	
Fmsy	0.220	0.700	0.210	0.400	0.200	0.220	0.150	
Ratio F 2010/Fmsy	9.255	0.417	1.433	2.455	3.550	4.700	2.133	
Exploitation status	overfishing	sustainable	overfishing	overfishing	overfishing	overfishing	overfishing	

The management option to technically separate the DPS fishery by sorting grids from the finfish fishery by OTB is evaluated by the theoretical definition of a fifth fishery targeting DPS only without by-catch of any other stock. Such fishery is called 'OTB dps'. The additional definition of a fifth fishery in the mixed fishery in GSA 9 is quantified and listed in Table 10.2.2.2.3. It can be taken from Table 10.2.2.2.3 that this fishery OTB dps is the only one among the operating fisheries which does not exploit a stock which is subject to overfishing.

Table 10.2.2.2.3 Technical interactions between five demersal fisheries and seven stocks jointly exploited. The stocks are defined in Table 10.2.2.2.1. Average partial fishing mortalities (age groups considered in brackets) are listed with the estimated total F in 2010 and in relation to the biological limit reference point Fmsy. The stocks' exploitation status and fisheries status are given.

GSA 9 Fishery	HKE (1-4)	DPS (1-4)	NEP (2-7)	MUT (1-4)	ARA (2-6)	ARS (2-6)	GAM (2-9)	Contribution to overfishing
OTB	1.008	0.000	0.301	0.918	0.021	0.000	0.320	yes
OTB dps	0.000	0.293	0.000	0.000	0.000	0.000	0.000	no
GNS	1.024	0.000	0.000	0.000	0.000	0.000	0.000	yes
GRT	0.004	0.000	0.000	0.027	0.000	0.000	0.000	yes
OTB deep	0.000	0.000	0.000	0.037	0.689	1.034	0.000	yes
F 2010	2.036	0.293	0.301	0.982	0.710	1.034	0.320	
Fmsy	0.220	0.700	0.210	0.400	0.200	0.220	0.150	
Ratio F 2010/Fmsy	9.255	0.419	1.433	2.455	3.550	4.700	2.133	
Exploitation status	overfishing	sustainable	overfishing	overfishing	overfishing	overfishing	overfishing	

The general goal of the applied multi-annual management plan (harvest control rule) is to sustainably exploit all seven stocks. This is planned to be realized by a maximum annual change in fishing mortality F by ±10%. In the case of overfishing (F>Fmsy), the F in the future year will be reduced by a maximum of 10 % or to Fmsy. In case of sustainable exploitation and in order to maintain it, the F in the following year is increased by a maximum or 10% or to Fmsy. Three scenarios to explore the mixed fisheries effects were conditioned as:

Scenario 1: Only one stock specific Fmsy is constraining the fisheries, which is the most productive stock. This implies catches beyond the specific conservation needs of the remaining stocks. There is no fisheries specific management, the fishing mortality of all fisheries contributing more than 5% to any F varies proportionally.

Scenario 2: All seven stock specific Fmsy are constraining the fisheries, the lowest F will actually be effective (lowest productive stock). This implies loss of potential catches of the other stocks. There is no fisheries specific management, the effort of all fisheries contributing more than 5% to any F varies proportionally. As all four fisheries contribute to overfishing of at least one of the seven stocks jointly exploited, there is no option to apply fisheries specific management schemes.

Scenario 3: All seven stock specific Fmsy are constraining the fisheries, the lowest F will actually be effective (lowest productive stock). This implies loss of potential catches of the other stocks. To minimize such losses, fisheries specific management is allowed to affect the fisheries according to their impact on overfishing, which is not the case regarding the OTB dps fishery sustainably exploiting DPS only and thus being allowed to continue such effect. Such annual variation in fisheries specific F (exploitation pattern) variation is constrained by a factor of 0.1 (10%).

Scenario 4: All seven stock specific Fmsy are constraining the fisheries, the lowest F will actually be effective (lowest productive stock). This implies loss of potential catches of the other stocks. To minimize such losses, fisheries specific management is allowed to affect the fisheries according to their impact on overfishing, which is not the case regarding the OTB dps fishery sustainably exploiting DPS only and thus being allowed to continue such effect. Such annual variation in fisheries specific F (exploitation pattern) variation is constrained by a factor of 0.3 (30%), in order to demonstrate the consequences of a more stringent strategy to achieve sustainability earlier.

10.2.3 Results and discussion

STECF EWG 11-12 noted that the use of average recruitment figures with a stochastic variations implies that the estimated stock dynamics and resulting productivity in the medium term projections are constrained by changes in survival (through mortality) and growth while there is no feedback from recruitment due to size of the stock. While this constraint on computation of recruitment is due to lack of knowledge it is implying rather low stock dynamics. STECF EWG 11-12 notes that the true stock dynamics under the simulated scenarios might be much higher with increased risk of fisheries collapses.

STECF EWG 11-12 noted that the catch composition of the four fisheries is quantitatively considered for seven stocks only, while the catch compositions of these fisheries are expected to be more diverse and composed of more stocks. **As such, STECF EWG 11-12 considers the definitions of the demersal fisheries as well as the results of presented the mixed fisheries simulations as illustrative and not representative in order to formulate management advice.**

Scenario 1: Constraining the fisheries by only one fishing mortality F of one specific stock implies that the management goal to sustainably exploit all four stocks is likely to be failed as fishing mortalities are indicated to increase further from unsustainable levels (Fig. 10.2.3.1). This scenario is believed to reflect the current management scheme most. The uptake of catch possibilities derived from maximum fishing mortalities (fishing effort) of seven stocks under the regime of one stock will risk continued decreases in stock size while catches of seven stocks remain rather stable and low. This result is driven by the applied assumption of rather stable recruitment with a feedback from the size of the spawning stock. Fishing mortality is projected to increase further for all stocks and to exceed or stay above the defined sustainable limit points Fmsy. The relative fishing effort is also estimated to increase for all fisheries.

Scenario 2: All seven sustainable stock specific F limits in exploitation are realized as the fishing mortalities are significantly reduced only by 2020 with the predefined annual reduction by 10%. Assuming a linear relationship between F and fishing effort, this simulation would largely reflect the GFCM management decision in 2009 (Resolution GFCM/33/2009/1 on the Management of demersal fisheries in the GFCM Area), if fully implemented. In fact, it appears that the rule to simultaneously exploit the stocks in a sustainable manner quickly leads towards the situation where one stock of poor productivity causes large amounts of catch possibilities of the other productive stocks not being taken. This is the reason for the continued reduction in median fishing mortality consistent for all seven stocks (Fig. 10.2.3.2). Such consistent reduction of fishing mortality leads to a significant increase in the stock sizes (SSB) of all seven stocks considered through increased survival. Although the catches estimated in scenario 2 are at a similar level as compared with scenario 1, the recovered stocks provide a high increase in security against fisheries collapses. Another major argument in favor of the sustainable mixed fishing strategy is the reduction in the estimated median relative fishing effort of three out of four fisheries (Fig. 10.2.3.2), which indicates a significant potential of increased catch rates and reduced investments which should be economically explored and quantified. The small GRT fishery would, after few years, contribute less than 5% to the fishing mortality of any of the overfished stock and therefore keep stable without significant reductions in effort. However, a problem would arise from defending management decisions regarding a reduction in certain fisheries even if one or more of their targeted stocks are fully recovered. In particular, the catch options of DPS as by-caught by the OTB fishery would largely remain unused.

Scenario 3: The resulting trends in stock recovery of this scenario 3 (Fig. 10.2.3.3), which actually allows for fisheries specific management, are rather similar to the scenario 2. Also the intended reductions in fishing mortalities towards the sustainable levels of the seven exploited stocks are very similar and will be reached by 2020. The major difference is the provided management option of fisheries specific management is the complete decoupling of the OTB dps fishery targeting the sustainably exploited pink shrimp DPS. This allows the sustainable catch possibility to be fully taken in a sustainable manner, which was not the case in scenario 2. The decoupling can also be seen in the trend of relative effort where the OTB dps fishery is the only significant activity which remains high without continued decreases and even reverse its trend towards increases. The remaining significant fisheries, OTB and GNS contributing to overfishing are obliged to reduce their effort. Reducing only the unsustainable fisheries and supporting the sustainable ones appears even more viable form an economic perspective. The overall catch estimates are higher in scenario 3 than in scenarios 1 and 2, with the already mentioned advantage regarding security against fisheries collapses.

Scenario 4: Scenario 4 has an identical set up as compared with scenario 3, i.e. that all seven Fmsy limits shall be achieved and that fisheries specific measures are foreseen, i.e. the OTB dps fishery shall be allowed to continue its activity as it does not contribute to overfishing. The only difference is that the annual variation in fishing mortality allowed to reach these goals is increased to 30% instead of the 10% of scenario 2. Consequently, the results are rather similar but the sustainable fishing is achieved significantly earlier, by 2015 rather than by 2020 as in the previous scenario (Fig. 10.2.3.4). The resulting trends in stock size indicate an even faster increase in stock size to higher levels while the resulting catches remain rather stable and at a slightly lower level caused by strongly reduced fishing mortalities. Again, the insignificant GRT fishery and the important OTB dps fishery are decoupled from the negative trend and only constrained by their stock specific limits of sustainable exploitation.

STECF EWG 11-12 notes that the implementation of the Fmsy limit for all stocks in mixed fisheries will provide strong incentives to decouple specific fisheries strategies in order to optimize the stock specific exploitation consistent with the sustainability. STECF EWG 11-12 reiterates its recommendation that the potential use of existing devices to improve the selectivity of mixed fisheries shall be evaluated and promoted in order to simplify overly complex fisheries strategies through reduction of by-catch. The avoidance of multi-targeted strategies may decrease the risk to be affected by overfishing of stocks in the by-catch and thus may contribute to the economic viability of respective fisheries.

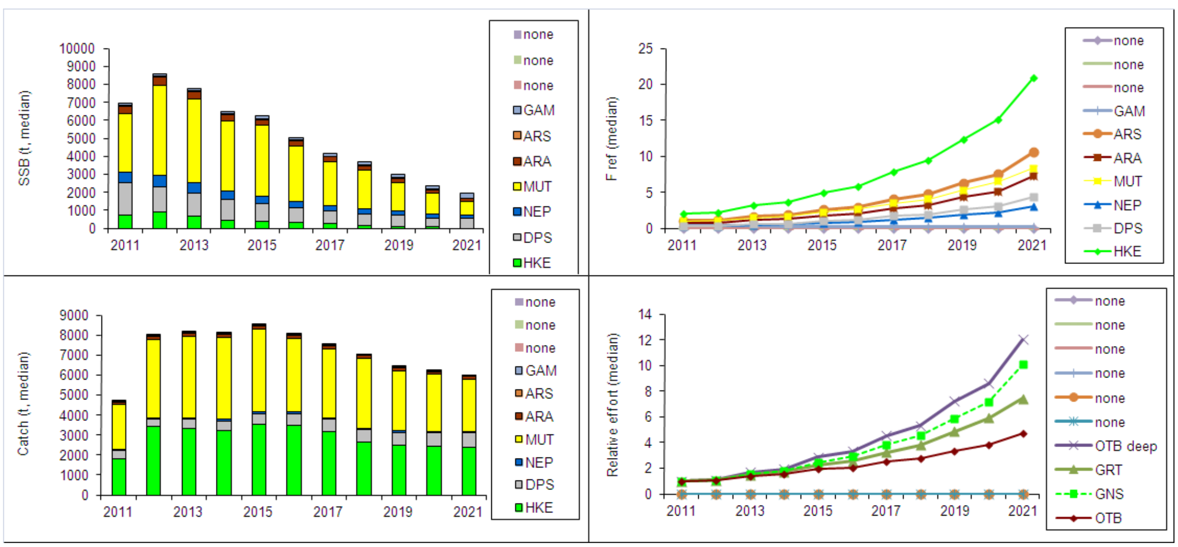


Fig. 10.2.3.1 Scenario 1: Median trends in SSB, catch, fishing mortality F and relative fishing effort.

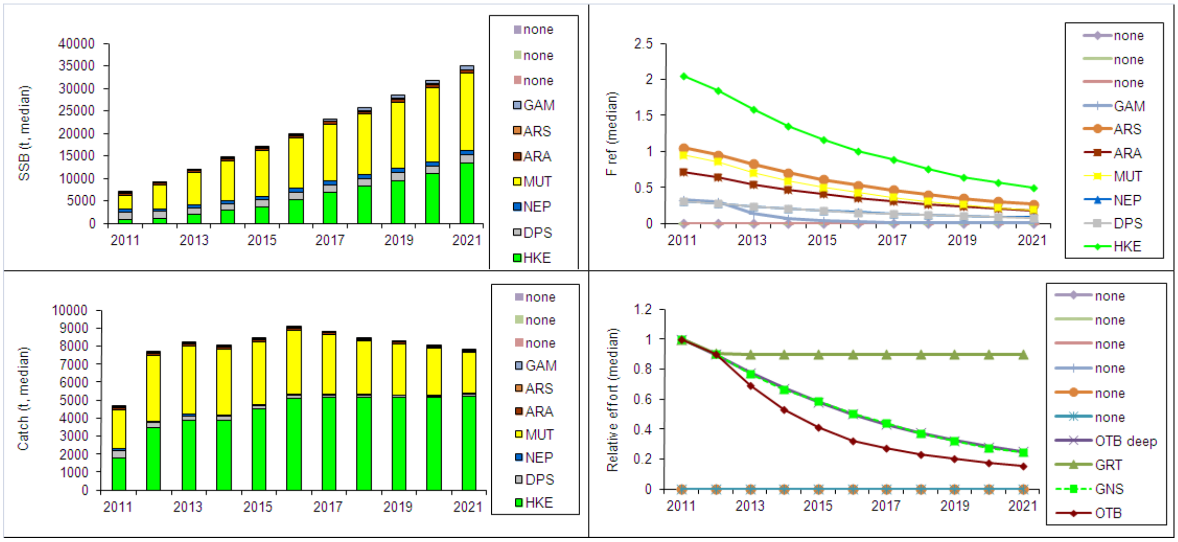


Fig. 10.2.3.2 Scenario 2: Median trends in SSB, catch, fishing mortality F and relative fishing effort.

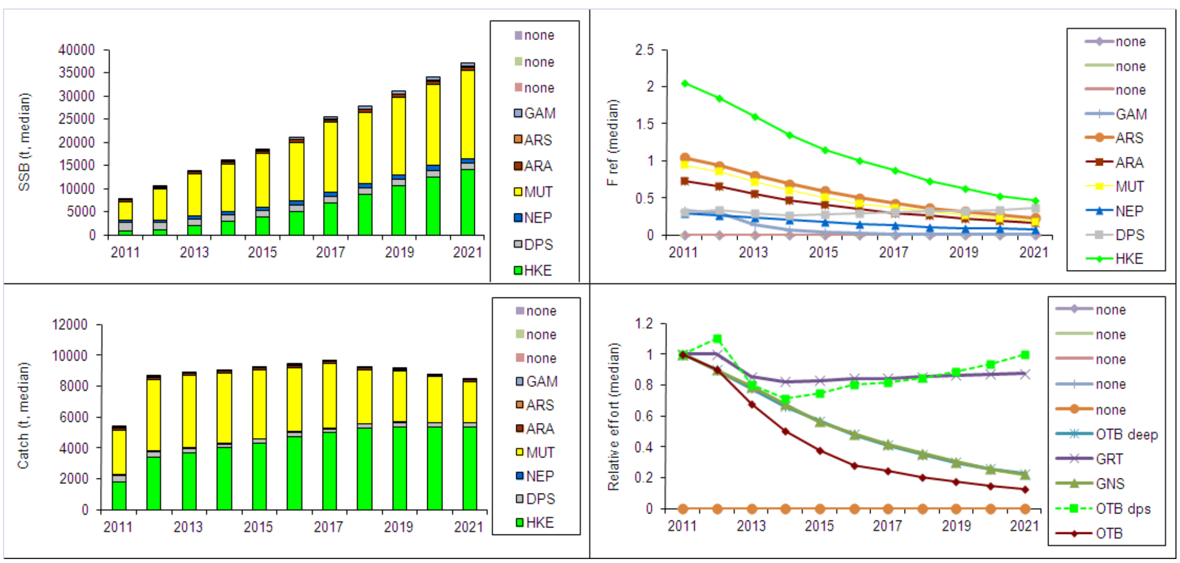


Fig. 10.2.3.3 Scenario 3: Median trends in SSB, catch, fishing mortality F and relative fishing effort.

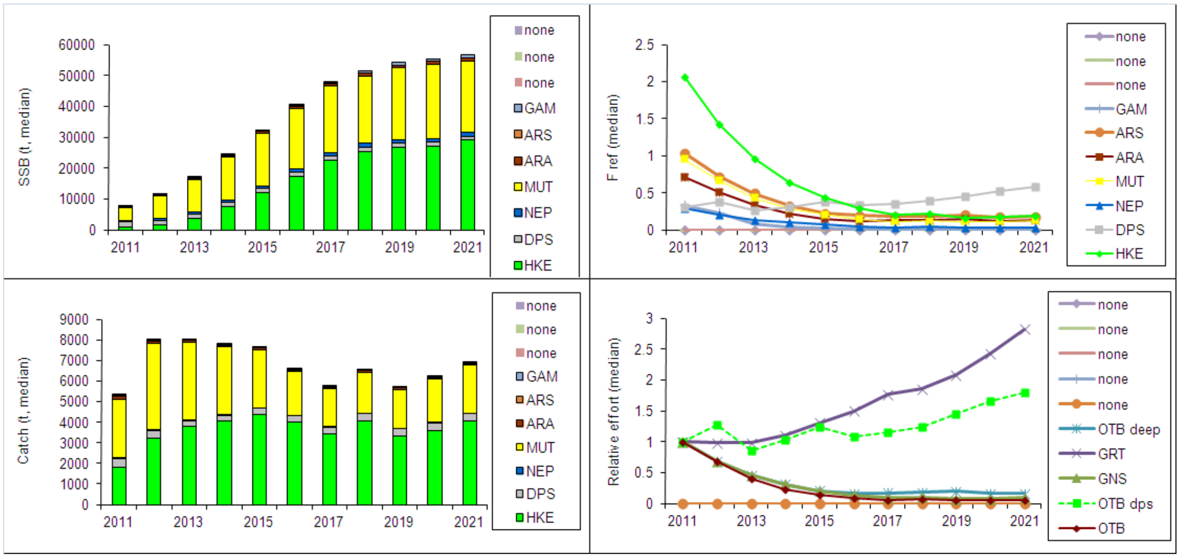


Fig. 10.2.3.4 Scenario 4: Median trends in SSB, catch, fishing mortality F and relative fishing effort.

11 TOR K FUTURE PLANNING OF MEDITERRANEAN EXPERT GROUP MEETINGS

EWG 11-12 noticed that the third meeting in the course of the year 2011 to estimate Mediterranean exploited stocks and fisheries, i.e. EWG 11-20 originally planned to be held during the week 12-16 December 2011, has been moved by the STECF bureau to the week 16-20 January 2012. The EWG 11-12 noticed that it received an informal invitation to hold the meeting EWG 11-20 in Madrid. The venue and logistics of that meeting is confirmed and will be disseminated through the dedicated website of this meeting.

12 TOR L OTHER BUSINESS

This Tor was focused on the following issues:

1. evaluate the influence of sea-bottom temperature on trawl swept-area estimations;
2. improving fishing effort descriptors: modeling engine power and gear-size relations;
3. Advise on the technical meaning of the *“mesh size opening”* concept and on the way such a mesh size is measured in relation to the diagonal and side of a mesh. Advise on the relation between “stretched mesh-size” and “mesh size opening”.
4. Advise on the equivalent stretched mesh size for a knotted polyamide net of a mesh size opening of 16 mm and a thickness of 210/2 denier; provide a conversion factor between mesh size opening and stretched mesh size for such a type of net;
5. Explain the meaning and correlation among different ways of expressing the twine thickness (e.g. mm; denier, etc.).
6. Assessment of Malta’s Fisheries Management Plan 2011-2015

12.1 Evaluate the influence of sea-bottom temperature on trawl swept-area estimations

12.1.1 Rationale

While a depth gauge is almost 100% accurate, sonar readings vary with the temperature in the sea. Sound propagates with different speeds depending on water temperature causing differences of up to 6-7% (i.e. 30-

35 meters at 500 meters depth). Just the difference of 10 degrees between summer and winter can cause variations of 12 or 13 meters. When fishing in all directions and along the bottom with large depth variations, the varying measurements will have a significant effect on the proper positioning of the trawl as well as trawl and trawl door movement in the sea.

When making accurate sonar measurements it is not enough to measure the temperature at the surface and at the bottom, split the measurement in two, and then base the sounder on the result. Different temperature layers, with different distributions, make it important to know the temperature profile from the surface to the bottom. In fact, scientists often stop several times a day to record the temperature with a CTD probe with cable. The temperature of the water where the gear is located is critical to the speed of sound and, by extension, to providing the correct measurement.

Recently Scanmar granted a patent for a much easier and convenient system to compensate such effect of temperature on speed sound. By logging data from the combined depth/temperature sensor during shooting of the equipment, an accurate temperature profile is generated and a modern sonar that has the proper input can adjust automatically or it can be adjusted to the best degree possible by hand. **At the moment all the Operative Units of Medits programme are using old gear monitoring systems without such compensation. We have investigated the effect of temperature on speed sound and then on gear openings and swept-area.**

12.1.2 Calculation of real sound speed in the sea water

It is well known that the temperature of the ocean affects the speed of sound and makes echo sounders provide incorrect depth readings. One can often see that the depth on the echo sounder differs from that stated on the map, and varies quite a bit from summer and winter, and often makes it difficult to fully benefit from the sea map. Figure 12.1.2.1 shows the speed of sound in function of water temperature at fixed depth of 0 m and 35 ppm of salinity.

In order to calculate the real speed of sound in sea water we have used the UNESCO equation. The International standard algorithm, often known as the UNESCO algorithm, is due to Chen and Millero (1977), uses pressure as a variable rather than depth.

For the original UNESCO paper see Fofonoff and Millard (1983). Wong and Zhu (1995) recalculated the coefficients in this algorithm following the adoption of the International Temperature Scale of 1990 (see Equation 1).

Both the UNESCO equation and the form modified by Won and Zhu (Equation 1) uses pressure as a variable instead of depth, because it is based on measurements made in small laboratory pressurized chambers. Useful guidance and suitable equations for converting pressure into depth and depth into pressure can be found in Leroy and Parthiot (1998). See their final key equation in Equation 2. Leroy and Parthiot (1998) give a table of corrections which are needed when the standard formula is applied to specific oceans and seas: $P(Z,\phi) = h(Z,\phi) - h_0 Z$.

The correction h_0Z is the correction applicable to common oceans. The corrective terms for Mediterranean is: $h_0 Z = -8.5 \cdot 10^{-6} Z + 1.4 \cdot 10^{-9} Z^2$. A full range of corrections may be found in Leroy and Parthiot (1998).

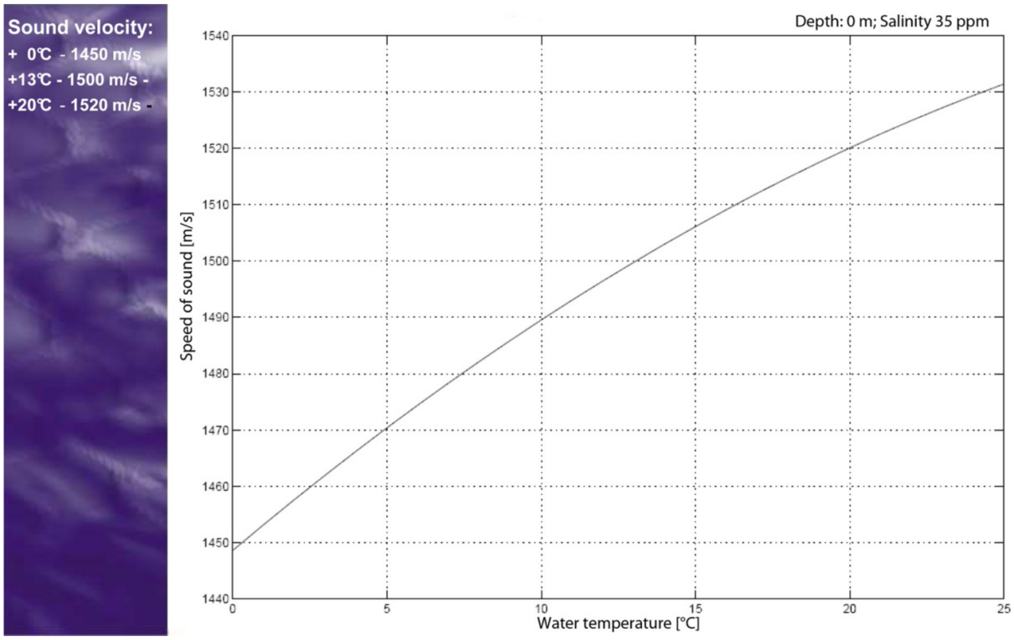


Figure 22.1.2.1 Speed of sound in the sea water. The curve has been calculated at depth of 0 m; salinity of 35 ppm (*Courtesy of Scanmar*).

$$c(S,T,P) = Cw(T,P) + A(T,P)S + B(T,P)S^{3/2} + D(T,P)S^2$$

$$\begin{aligned} Cw(T,P) = \; & (C_{00} + C_{01}T + C_{02}T^2 + C_{03}T^3 + C_{04}T^4 + C_{05}T^5) + \\ & (C_{10} + C_{11}T + C_{12}T^2 + C_{13}T^3 + C_{14}T^4)P + \\ & (C_{20} + C_{21}T + C_{22}T^2 + C_{23}T^3 + C_{24}T^4)P^2 + \\ & (C_{30} + C_{31}T + C_{32}T^2)P^3 \end{aligned}$$

$$\begin{aligned} A(T,P) = \; & (A_{00} + A_{01}T + A_{02}T^2 + A_{03}T^3 + A_{04}T^4) + \\ & (A_{10} + A_{11}T + A_{12}T^2 + A_{13}T^3 + A_{14}T^4)P + \\ & (A_{20} + A_{21}T + A_{22}T^2 + A_{23}T^3)P^2 + \\ & (A_{30} + A_{31}T + A_{32}T^2)P^3 \end{aligned}$$

$$B(T,P) = B_{00} + B_{01}T + (B_{10} + B_{11}T)P$$

$$D(T,P) = D_{00} + D_{10}P$$

Equation 1. UNESCO equation as recalculated by Wong and Zhu (1995). The coefficients in this algorithm following the adoption of the International Temperature Scale of 1990 and are reported in Table 32.1.2.1. T: temperature in degrees Celsius; S: salinity in Practical Salinity Units (parts per thousand); P: pressure in bar. *Range of validity: temperature 0 to 40 °C, salinity 0 to 40 parts per thousand, pressure 0 to 1000 bar (Wong and Zhu, 1995).*

$$h(Z,\Phi) = h(Z,45) \times k(Z,\Phi)$$

$$h(Z,45) = 1.00818 \times 10^{-2} Z + 2.465 \times 10^{-8} Z^2 - 1.25 \times 10^{-13} Z^3 + 2.8 \times 10^{-19} Z^4$$

$$k(Z,\Phi) = (g(\Phi) - 2 \times 10^{-5} Z)/(9.80612 - 2 \times 10^{-5} Z)$$

$$g(\Phi) = 9.7803(1 + 5.3 \times 10^{-3} \sin^2\Phi)$$

Equation 2. The formula $P(= h(Z,\phi))$ is for oceanographers standard ocean (ideal medium with a temperature of 0°C and salinity of 35 ppt). Z: depth in metres; h: pressure in MPa (relative to atmospheric pressure); ϕ: latitude.

Table 42.1.2.1 Table of coefficients used in Equation 1.

Coefficients	**Numerical values**	**Coefficients**	**Numerical values**
C_{00}	1402.388	A_{02}	7.166E-5
C_{01}	5.03830	A_{03}	2.008E-6
C_{02}	-5.81090E-2	A_{04}	-3.21E-8
C_{03}	3.3432E-4	A_{10}	9.4742E-5
C_{04}	-1.47797E-6	A_{11}	-1.2583E-5
C_{05}	3.1419E-9	A_{12}	-6.4928E-8
C_{10}	0.153563	A_{13}	1.0515E-8
C_{11}	6.8999E-4	A_{14}	-2.0142E-10
C_{12}	-8.1829E-6	A_{20}	-3.9064E-7
C_{13}	1.3632E-7	A_{21}	9.1061E-9
C_{14}	-6.1260E-10	A_{22}	-1.6009E-10
C_{20}	3.1260E-5	A_{23}	7.994E-12
C_{21}	-1.7111E-6	A_{30}	1.100E-10
C_{22}	2.5986E-8	A_{31}	6.651E-12
C_{23}	-2.5353E-10	A_{32}	-3.391E-13
C_{24}	1.0415E-12	B_{00}	-1.922E-2
C_{30}	-9.7729E-9	B_{01}	-4.42E-5
C_{31}	3.8513E-10	B_{10}	7.3637E-5
C_{32}	-2.3654E-12	B_{11}	1.7950E-7
A_{00}	1.389	D_{00}	1.727E-3
A_{01}	-1.262E-2	D_{10}	-7.9836E-6

12.1.3 Dataset used

A dataset of twenty-three hauls have been used for investigating the effect of temperature on swept-area. The dataset has been provided by an Operative Unit involved in the Medits programme (Table 1.1.3.1). For right of privacy, data owners are not reported in the current report.

Gear performance, that is horizontal (HNO) and vertical net opening (VNO), was measured on seventeen hauls using the C604 gear monitoring system (Scanmar, Norway). A laptop automatically controlled data acquisition and provided for real time correct system functioning through customized software. The main goal of these measurements was to obtain for each haul detailed, real time data on gear performance as well as effective duration of the towing time, which is the time from optimum gear openings (start) to the time when the speed was reduced to recover the warp (end).

The Unit provided for each haul also the Vemco minilog data, which make possible to calculate the effective temperature of the sea water and the depth of the fishing gear. The minilog was mounted at the centre of the headrope. Data from the sea trials, together with the results obtained by the temperature compensation formulae proposed in Equation 1 and Equation 2, are summarized in Error! Not a valid bookmark self-reference..

Table 2.1.3.1 Summary of the hauls provided by an operative unit of the Medits programme. HNO: horizontal net opening; VNO: vertical net opening; TS: towing speed.

Id Haul	Haul Validity	PAYS	Date	Haul duration	Depth start [m]	Depth end [m]	Mean Depth (m)	Towed linear distance [m]	HNO [m]	VNO [m]	Towed Explored Area (km^2)	TS [m/s]	TS [kn]
48	V	ITA	08/06/2010	30	26	26	26	2740	15.90	2.18	0.0436	1.52	2.96
49	V	ITA	06/06/2010	30	40	36	38	2666	15.90	2.18	0.0424	1.48	2.88
50	V	ITA	06/06/2010	30	37	40	39	2685	15.90	2.18	0.0427	1.49	2.90
51	V	ITA	06/06/2010	30	62	58	60	2574	17.70	2.04	0.0466	1.46	2.84
52	V	ITA	05/06/2010	30	74	82	78	2630	17.70	2.04	0.0456	1.43	2.78
53	V	ITA	07/06/2010	30	76	76	76	2574	17.70	2.04	0.0456	1.43	2.78
54	V	ITA	06/06/2010	30	109	114	112	2666	18.00	1.99	0.0480	1.48	2.88
55	V	ITA	06/06/2010	30	123	123	123	2722	18.00	1.99	0.0490	1.51	2.94
56	V	ITA	06/06/2010	30	113	113	113	2648	18.00	1.99	0.0477	1.47	2.86
57	V	ITA	06/06/2010	30	119	114	117	2722	18.00	1.99	0.0490	1.51	2.94
58	V	ITA	07/06/2010	30	124	104	114	2315	18.00	1.99	0.0417	1.29	2.50
59	V	ITA	05/06/2010	60	409	398	404	5112	18.80	1.96	0.0961	1.42	2.76
60	V	ITA	05/06/2010	60	380	400	390	5018	18.80	1.96	0.0943	1.39	2.71
61	V	ITA	08/06/2010	45	384	384	384	4018	18.80	1.96	0.0755	1.49	2.90
62	V	ITA	08/06/2010	60	224	277	251	5408	18.80	1.96	0.1017	1.50	2.92
63	V	ITA	06/06/2010	60	320	349	335	5296	18.80	1.96	0.0996	1.47	2.86
64	V	ITA	07/06/2010	60	327	262	295	5074	18.80	1.96	0.0954	1.41	2.74
65	V	ITA	05/06/2010	60	522	598	560	5222	19.30	1.95	0.1008	1.45	2.82
66	V	ITA	05/06/2010	60	518	553	536	4760	19.30	1.95	0.0919	1.32	2.57
67	V	ITA	05/06/2010	60	558	531	545	4963	19.30	1.95	0.0958	1.38	2.68
68	V	ITA	07/06/2010	60	542	509	526	4944	19.30	1.95	0.0954	1.37	2.67
69	V	ITA	08/06/2010	60	524	718	621	5074	19.30	1.95	0.0979	1.41	2.74
70	V	ITA	07/06/2010	60	584	540	562	5148	19.30	1.95	0.0994	1.43	2.78

Error! Not a valid bookmark self-reference. Results obtained from sea trials (HN: haul number). In the table are reported for horizontal net opening (HNO), vertical net opening (VNO), haul duration (HD), and swept trawl area (STA) the values calculated by the Medits unit (MEDIT, in red) on the basis of an unknown method, the values measured by the Scanmar system (SCAN), and the recalculated Scanmar values considering the temperature compensation analysis (REAL). The sea water temperature (SWT) and headrope depth (HRD) have been calculated by using the Vemco Minilog data. All the Errors due to an improper post-processing (MED/SCAN) and by an uncompensated temperature effect on speed sound (SCAN/REAL) are reported for HNO, VNO, HD, and STA.

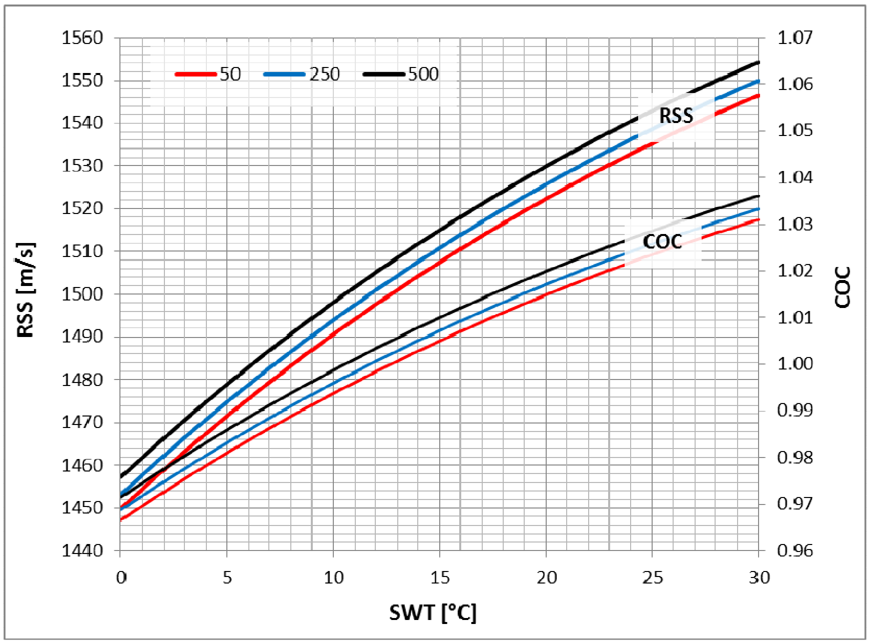
HN	HNO			VNO			Minilog		Error(HNO)		Error(VNO)	STA		HD		Error(HD)	Error(STA)
	MEDIT	SCAN	REAL	MEDIT	SCAN	REAL	SWT	HRD	MED/SCAN	SCAN/REAL	MED/SCAN	MEDIT	SCAN	MEDIT	SCAN	MED/SCAN	MED/SCAN
48	*15.90*	15.14	15.31	*2.18*	2.19	2.21	18.2	23.0	-4.8%	1.11%	0.3%	43566	36867	30	26:40	-11.1%	-15.4%
49	*15.90*	16.40	16.55	*2.18*	2.09	2.11	17.1	35.8	3.1%	0.92%	-4.3%	42389	40069	30	27:30	-8.3%	-5.5%
50	*15.90*	16.86	16.99	*2.18*	1.95	1.96	16.3	34.5	6.0%	0.75%	-10.8%	42692	33954	30	22:30	-25.0%	-20.5%
51	*17.70*	17.52	17.58	*2.04*	1.87	1.88	14.3	69.7	-1.0%	0.37%	-8.2%	46551	39156	30	25:30	-15.0%	-15.9%
52	*17.70*	-	-	*2.04*	-	-	14.9	56.2	-	-	-	45560	-	30	-	-	-
53	*17.70*	-	-	*2.04*	-	-	14.4	70.7	-	-	-	45560	-	30	-	-	-
54	*18.00*	18.41	18.49	*1.99*	2.17	2.18	14.3	106.3	2.3%	0.41%	9.0%	47988	40909	30	25:00	-16.7%	-14.8%
55	*18.00*	20.34	20.43	*1.99*	1.50	1.51	14.2	119.4	13.0%	0.40%	-24.4%	48996	46455	30	25:10	-16.1%	-5.2%
56	*18.00*	18.33	18.40	*1.99*	2.11	2.12	14.2	109.0	1.8%	0.40%	6.1%	47664	40979	30	25:20	-15.6%	-14.0%
57	*18.00*	17.48	17.55	*1.99*	2.24	2.25	14.2	114.4	-2.9%	0.39%	12.5%	48996	41765	30	26:20	-12.2%	-14.8%
58	*18.00*			*1.99*	-	-	14.1	111.9	-	-	-	41670		30	-	-	-
59	*18.80*	18.96	19.09	*1.96*	2.09	2.10	14.2	398.4	0.8%	0.72%	6.5%	96106	69717	60	43:10	-28.1%	-27.5%
60	*18.80*	19.74	19.88	*1.96*	2.09	2.10	14.3	382.4	5.0%	0.72%	6.5%	94338	76199	60	46:10	-23.1%	-19.2%
61	*18.80*	-	-	*1.96*	-	-	14.2	381.5	-	-	-	75538	-	45	-	-	-
62	*18.80*	-	-	*1.96*	-	-	14.3	219.6	-	-	-	101670	-	60	-	-	-
63	*18.80*	19.60	19.73	*1.96*	1.99	2.00	14.2	327.2	4.3%	0.65%	1.6%	99565	90262	60	52:10	-13.1%	-9.3%
64	*18.80*	19.49	19.62	*1.96*	1.77	1.79	14.3	350.4	3.7%	0.68%	-9.5%	95391	61249	60	37:10	-38.1%	-35.8%
65	*19.30*	18.53	18.70	*1.95*	1.93	1.95	14.2	540.3	-4.0%	0.88%	-1.1%	100785	51078	60	31:40	-47.2%	-49.3%
66	*19.30*	18.13	18.29	*1.95*	2.14	2.15	14.2	520.1	-6.1%	0.85%	9.5%	91868	61611	60	42:50	-28.6%	-32.9%
67	*19.30*	19.20	19.37	*1.95*	1.96	1.98	14.2	553.0	-0.5%	0.89%	0.7%	95786	66438	60	41:50	-30.3%	-30.6%
68	*19.30*	17.21	17.36	*1.95*	1.94	1.96	14.2	561.4	-10.8%	0.90%	-0.5%	95419	71600	60	50:30	-15.8%	-25.0%
69	*19.30*	-	-	*1.95*	-	-	14.2	546.0	-	-	-	97928		60	-	-	-
70	*19.30*	19.28	19.46	*1.95*	1.64	1.66	14.2	594.9	-	-	-15.7%	99356	79952	60	48:20	-19.4%	-19.5%

Results

12.1.3.1 Temperature compensation

As regards temperature compensation we found that in the current dataset, the temperature at the headrope level (Minilog data) ranged from 14 to 18 °C, which caused a Scanmar sound speed of around 1505-1517 m/s. Considering the standard sound speed in sea water used by the Scanmar of 1500 m/s, the error in horizontal net opening (HNO) measurements and therefore in swept trawl area (STA) estimation was around 1%, ranging from 0.4 to 1.1% (Error! Not a valid bookmark self-reference.).

During summer periods in Mediterranean, we might have temperature around 30°C, so in shallow waters (~50 m) the effect of temperature falls on HNO and VNO by a coefficient of 1.03-1.04 (**Error! Reference source not found.**.1.3.1.1). For fishing depths of 50, 250 and 500 m, **Error! Reference source not found.**.1.3.1.1 provides three curves of the coefficient of compensation needed to correct the trawl openings HNO and VNO obtained by the Scanmar sensors. By knowing the fishing depth and sea water temperature during the survey, it might be possible to apply such compensation to the Scanmar measurements (HNO and VNO).



Error! Reference source not found..1.3.1.1 Real effective speed of sound (RSS) in relation of sea water temperature (SWT) at three different depths (50, 250 and 500 m). Coefficient of compensation (COC) at each depth is provided in the graph for an easy correction of the trawl openings HNO and VNO obtained by Scanmar sensors.

12.1.3.2 Post-processing of technological sea trials data

In the current dataset, haul duration (HD) has been arbitrarily fixed to 30 or 60 minutes, which caused an underestimation of HD ranging from -10% to -20%. The real HD values have been calculated by processing the collected Scanmar data (Error! Not a valid bookmark self-reference.). In hauls at a fishing depth >300 m, the error in time duration resulted between -20 and -40% (Error! Not a valid bookmark self-reference.). The Operative Unit calculated the horizontal net opening (HNO) in each haul by averaging all the hauls in the same depth-layer (or stratum). In this case the errors varied between -10% and +10%.

The combined effect of the above reported errors of HD and HNO assessment falls on the evaluation of the Towed Explored Area. In particular, for hauls of 30-minutes the error varied around -5% and -10% and for hauls of 60-minutes the error was between -10% and -50%. Therefore the total catch was often underestimated.

12.1.4 Recommendations

- During trawl survey, when possible always use gear monitoring systems (e.g. Scanmar, Simrad, Notus, Netmind, Marport, etc.), if not possible due to risky hauls (e.g. rocks, relicts, etc.) a reliable model should be used to interpolate any missing values;
- for catch standardization, the horizontal net opening (HNO) measured by gear monitoring systems in each haul must be used at least on a relevant number of hauls in different strata each year. Averaging the HNO data by stratum implies loss of information;
- data acquisition must start at the "cable fixing (t_f)" and finish at the "cable hauling (t_c)". The starting point of the haul must be the time when the gear is stable (t_i) in terms of openings (both HNO and VNO). The haul duration (HD) must be calculated by subtracting the two times: HD=t_c-t_i.
- towing distance (TD) is one of the most complicated parameter to be calculated and, with HD, it is even the most important one for the estimation of the swept-area (STA). Probably in the current Medits dataset, it has been calculated as TD[m]=TS[m/s] x HD[s]. However, when we have hauls with changing courses (e.g. not straight lines) we can underestimate the distance towed. A common approach is recommended by all Units. For example by integrating the distances covered on small intervals of time (t<=5 minutes).
- nevertheless the foregoing recommendations, if a certain Medits Unit adopts the same approach in making quantitative predictions of HNO from the other parameters (cable length, depth, VNO, bridles length, etc.) or for the calculation of both HD and TD, such approach must be consistent throughout the years, keeping eventual errors constant in the time series. However, this has been often infringed looking at the exploratory analysis of the Medits database. See for further information Section 1.6 below;
- establishment of a new group of gear technologists to investigate regularly the full standardization of the Medits trawl survey (gear parameters, use of the gear and processing of data) in accordance with the protocol;
- the new group of gear technologists should report regularly to the Medits coordination group the findings of the investigations. The group is best placed under the umbrella of Medits group.

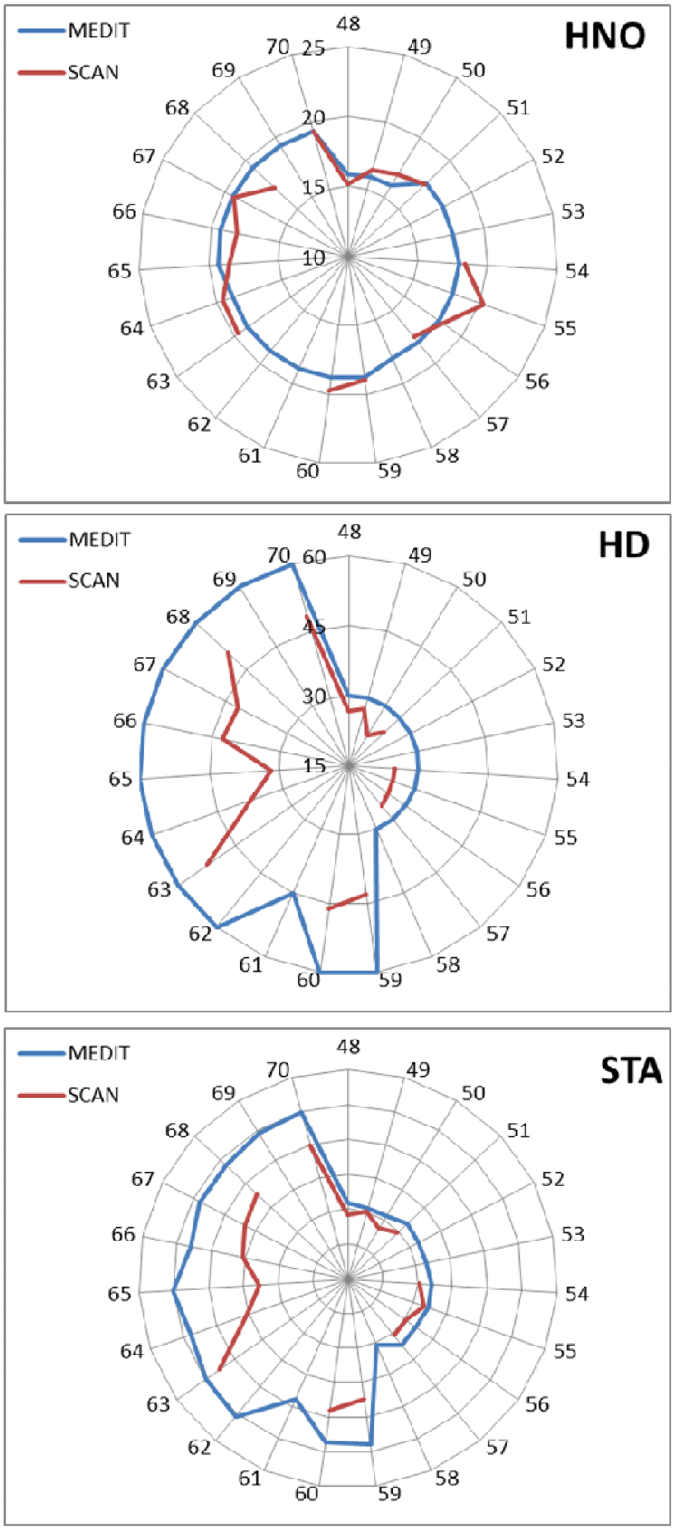


Figure 12.1.4.1 Radar graphs showing the differences between the values calculated by the Medits Unit (Medit) and the values obtained on the basis of the Scanmar data (temperature uncompensated values) of the following parameters: horizontal net opening (HNO), haul duration (HD), and swept trawl area (STA) in each haul (from haul 48 to 70). The effective duration of the towing time (HD) is the time from optimum gear openings (start) to the time when the speed was reduced to recover the warp (end).

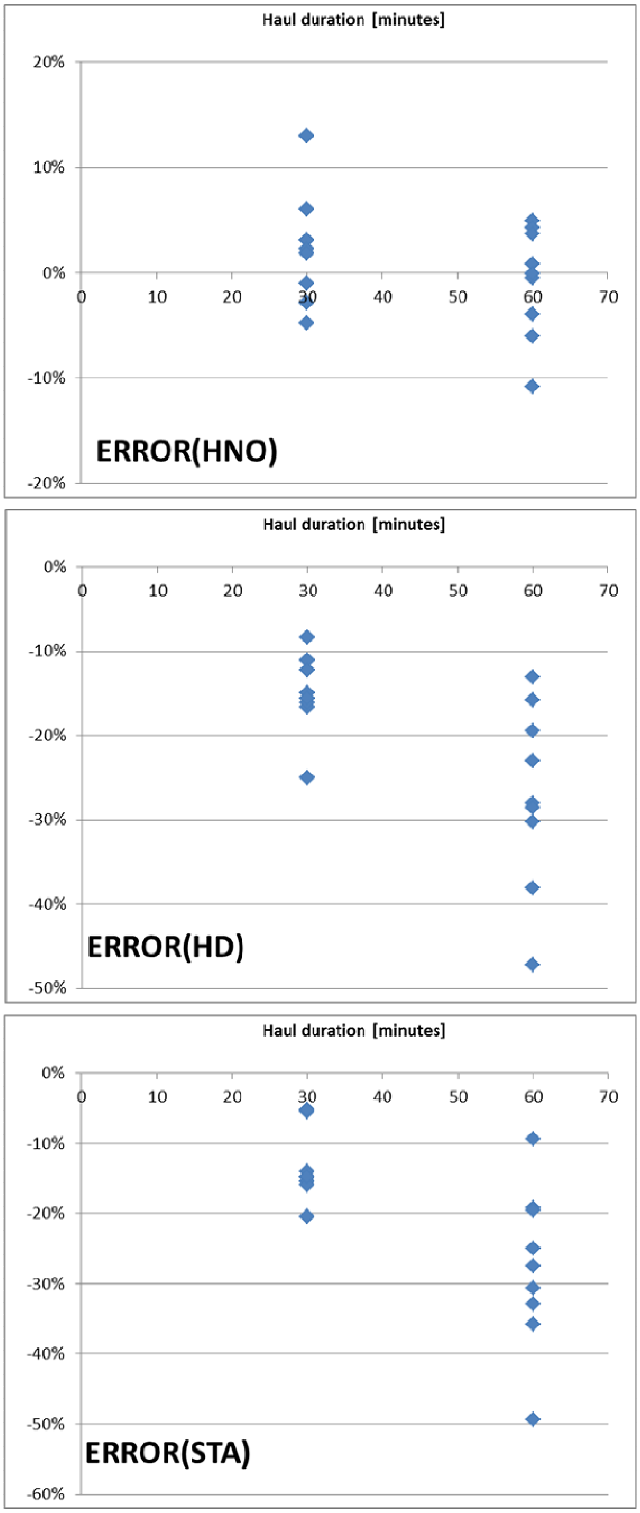


Figure 12.1.5.2 Errors due to an improper post-processing by contrasting the values calculated by the Medits Unit (Medit) and the values obtained on the basis of the Scanmar data (temperature uncompensated values) of the following parameters: horizontal net opening (HNO), haul duration (HD), and swept trawl area (STA) in each haul. The values have been plotted against the arbitrary haul duration used by the Medits Unit (30-minutes and 60-minutes). The effective duration of the towing time (HD) is the time from optimum gear openings (start) to the time when the speed was reduced to recover the warp (end).

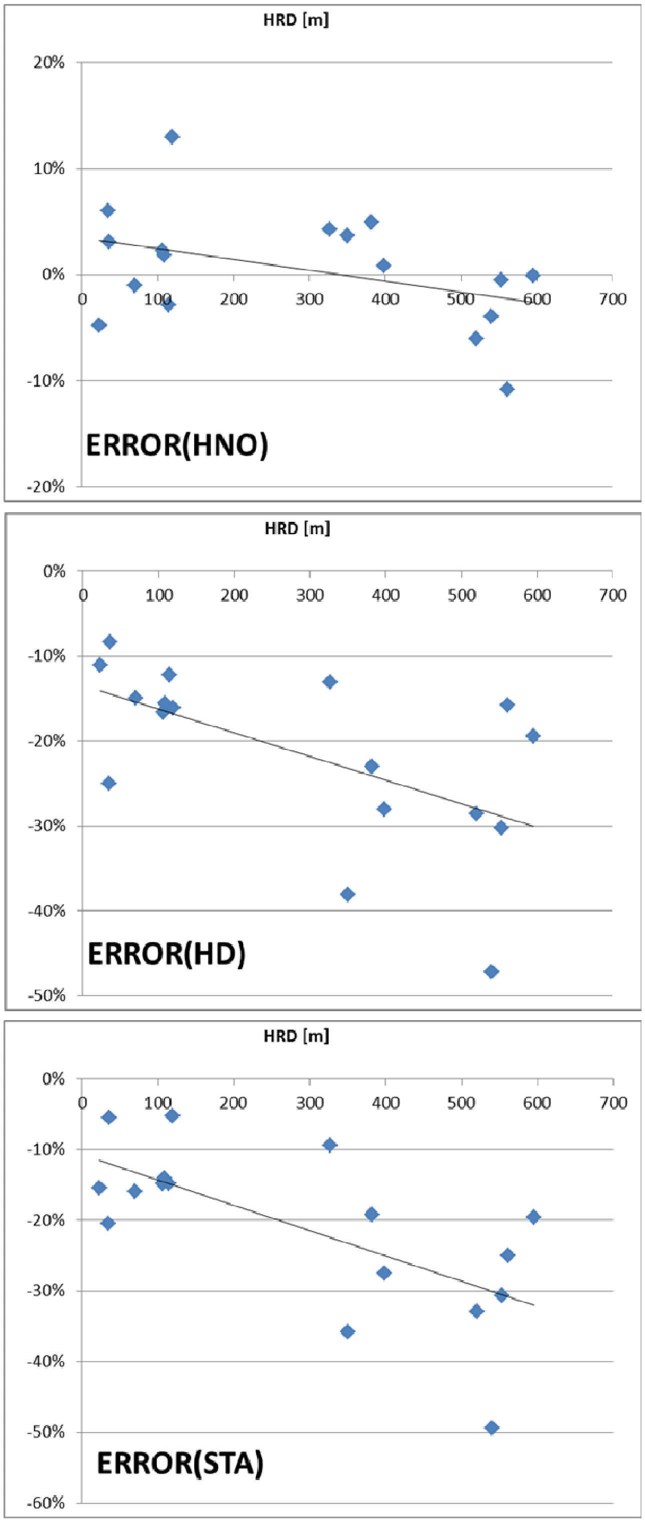


Figure 12.1.4.3 Errors due to an improper post-processing by contrasting the values calculated by the Medits Unit (Medit) and the values obtained on the basis of the Scanmar data (temperature uncompensated values) of the following parameters: horizontal net opening (HNO), haul duration (HD), and swept trawl area (STA) in each haul. The values have been plotted against the headrope depth obtained by Vemco minilog. The effective duration of the towing time (HD) is the time from optimum gear openings (start) to the time when the speed was reduced to recover the warp (end).

12.1.5 Exploratory analysis of the Medits gear performance parameters.

In the context of performing a quality check of the Medits database generated with the DCF call of August 2011, a detailed exploration of gear monitoring was made. Given the importance of a correct estimation of swept area for the construction of survey indexes, particular care needs to be devoted to parameters such as horizontal net opening, haul duration and distance towed. Table 3 shows the number of hauls performed in each GSA by the different vessels over the period 1994-2010.

Table 3 Number of hauls performed in each GSA by the different vessels over the period 1994-2010.

AREA	1	5	6	9	10	11	15	16	17	18	19	25
VESSEL												
AND	0	0	0	0	0	0	0	0	1661	0	0	0
BIM	0	0	0	0	0	0	0	0	0	144	285	0
CIR	0	0	0	120	0	0	0	0	0	0	0	0
COR	654	260	1253	0	0	0	0	0	0	0	0	0
DAP	0	0	0	0	70	0	0	0	0	0	0	0
EGU	0	0	0	0	0	0	0	0	2	0	0	0
EVA	0	0	0	0	0	0	0	0	0	0	0	102
FRP	0	0	0	1344	0	0	0	0	0	0	0	0
GAB	0	0	0	0	70	0	0	0	0	0	0	0
GIS	0	0	0	0	0	681	0	0	0	0	0	0
IGO	0	0	0	0	0	0	0	0	2	0	0	0
LIB	0	0	0	840	0	0	0	0	0	0	0	0
MEG	0	0	0	0	0	0	0	0	0	0	0	54
NUS	0	0	0	0	0	1175	0	0	0	0	0	0
PEC	0	0	0	0	490	0	0	0	0	1482	937	0
PRI	0	0	0	0	0	0	0	0	2	0	0	0
SAN	0	0	0	0	678	0	360	1225	0	0	0	0

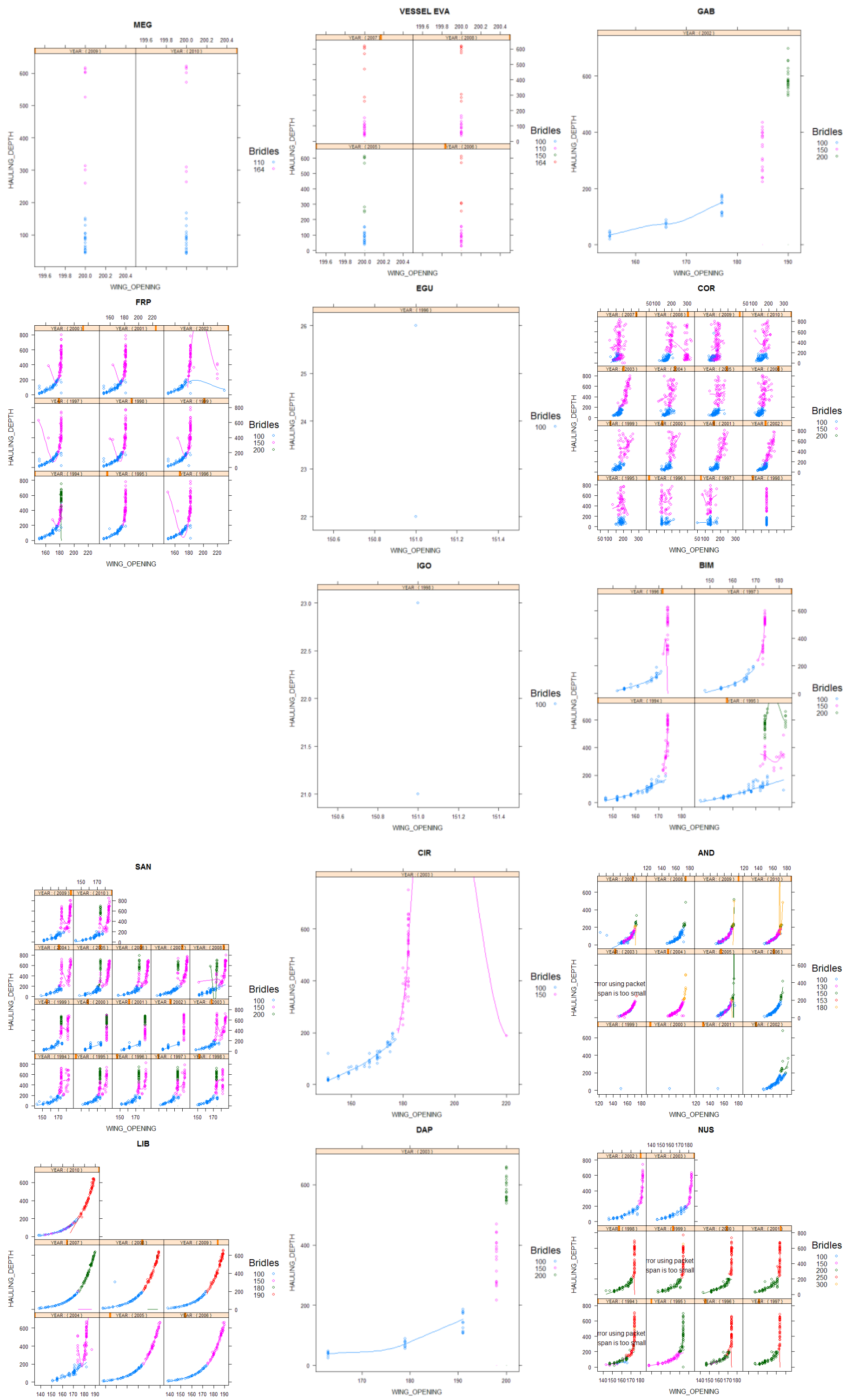
By individual vessel, year and bridle length the relationship between HNO and Hauling depth was explored and a separate LOESS smoother was fitted to each bridle length. From this analysis emerges that many Operative Units have used fixed horizontal net opening values (HNO) without any distinctions among hauls carried out at different depths and/or different bridle lengths (Figure. 12.1.5.1).

Such units (MEG, EVA, EGU, IGO, PRI) have probably decided to not use real measured HNOs or do not have a gear monitoring system at all. Some others (GIS, GAB, BIM, DAP) have used a mixed approach, on the basis of the bridles length (or fishing depth) they used either fixed values or measured HNO. In the case of fixed values or wing opening derived from regression models, by comparison with the estimated wing opening measured on vessel like COR, it is clear that not using SCANMAR reduces the variability of wing opening. The consequence is that, when using estimated rather than measured wing openings, we will be overconfident in the derived CPUE indexes since the swept area variability is artificially removed.

The analysis has been broken down by time of the survey and some operative units (PEC, GIS, LIB, NUS) have not used a constant model between HNO and hauling depth as it appears from parallel curves in the smoothers. This might have been caused by different reasons: changes in the trawl behaviour due to changes occurred during the trawl manufacture or differences throughout the years in the gear rigging adopted or different models used to estimate wing opening; etc. This variability is of great concern since it potentially introduces yearly non-random bias which could seriously impact the reliability of the CPUE indexes derived from MEDITS.

Minor problem: CIR has probably a typo in the data input.

Understanding precisely what gear monitoring protocol each vessels/research group is following is fundamental to verify and fix violations and inconsistencies with the MEDITS protocol. Assessing how swept area is calculated is also a fundamental aspect of the standardization of the CPUEs with regression models such as GLM/GAM. If swept area is non-randomly biased it is better to model the numbers of fish (or weight) and have either swept area as an offset parameter or even as a predictor covariate.


MEG
VESSEL EVA
GAB
FRP
EGU
COR
IGO
BIM
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AND
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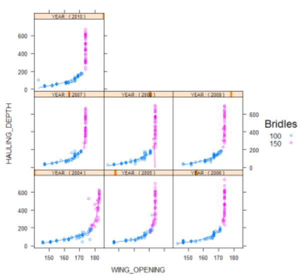
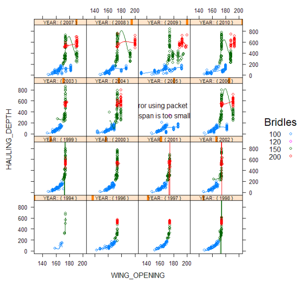
NUS
HAULING_DEPTH
WING_OPENING
Bridles

GIS


HAULING_DEPTH
WING_OPENING
Bridles
100
150

PEC


HAULING_DEPTH
WING_OPENING
Bridles
100
120
150
200

PRI

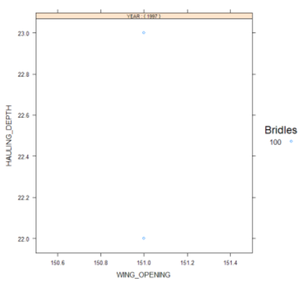

HAULING_DEPTH
WING_OPENING
Bridles
100

Figure 12.1.5.1 Exploratory analysis of horizontal net opening (wing_opening) by hauling depth (hauling_depth) in eighteen Operative Units involved in the Medits programme. Horizontal net openings and respective models have been differentiated by bridle lengths.

12.2 Improving fishing effort descriptors: modelling engine power and gear-size relations.

An interesting paper has been published by Eigaard et al. (2011). In this paper, based on information from an international inventory of gears currently deployed by trawlers in five European countries, the relationship between vessel engine power and trawl size was quantified for different types, trawling techniques and target species.

A linear relationship between fishing circle and horsepower seems feasible within the range of engine power observations available to this study. However, departures from this linearity due to e.g. the introduction of high performance netting or the presence of some functional limitation of trawl size increase at higher engine powers cannot be ruled out. These analyses suggested that a relationship exists for smaller vessels but that this breaks down for larger vessels and that a logarithmic fit is better than a linear.

Furthermore, trawl fishing circle is an integrated expression of many other gear components such as optimal trawling speed, door and ground gear drag resistance, netting resistance, and cutting rate of the trawl.

The modelling results have implications for the reliability of kilowatt days as descriptor of effective effort and point to the need of including metrics relating to the size and geometry of gear deployed in routine monitoring of fish effort.

Future works are foreseen within the Framework of Marea project (*Framework service contract for scientific advice and other services for the implementation of the common fisheries policy in the Mediterranean, Service Contract Nr. SI2 580480*), financed by the EC Commission through the Open Call for Tenders MARE/2009/05-Lot1). In forthcoming Specific Contract, only Mediterranean data will be analysed. The collection of the relevant information in Mediterranean trawl fisheries will be guaranteed by the partners involved through the review of the available information (papers, technical reports etc.) and interviews with net-makers and other independent source of information. Furthermore direct measurements will be carried out in order to implement the information collected in the review. The data collected will be the basis for the following data analysis and modelling. However, new gear classification will be developed and applied for a definition of a new model.

12.3 Advise on the technical meaning of the "mesh size opening" concept and on the way such a mesh size is measured in relation to the diagonal and side of a mesh. Advise on the relation between "stretched mesh-size" and "mesh size opening".

12.3.1 Rationale

As regards the current request, relevant Commission Regulations are EC Reg. 129/2003, 1967/2006, and 517/2008. The term "mesh size opening" can be read only in the Art. 9 of the EC Reg. 1967/2006 par. 6 *"Bottom-set gillnets shall not have a mesh size opening smaller than 16 mm"*. **Assuming that such term can be outlined by both values of the internal diagonals (see** Error! Reference source not found.**), we hereby provides some advices on the technical meaning of the mesh size opening and on the way such parameter can be related to the stretched mesh size and mesh size opening.** In this connection we would like to underline that, in the Italian translation, the Art. 9 of the EC Reg. 1967/2006 paragraph 6 abovementioned we read *"la dimensione delle maglie delle reti da imbrocco calate sul fondo non è inferiore a 16 mm"*, which means *"Bottom-set gillnets shall not have a mesh opening smaller than 16 mm"*. With the term mesh size opening translated as mesh opening.

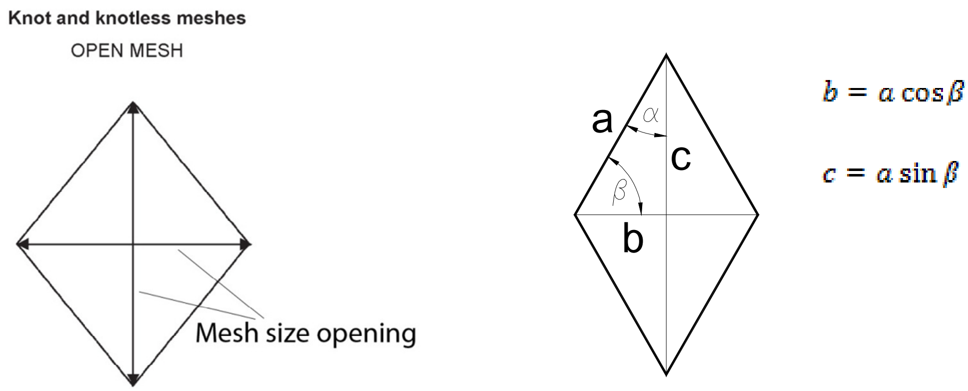


Figure 12.3.1.1 Open mesh, the parameter "mesh size opening" can be outlined by the values of both the internal diagonals (c and b).

12.3.2 Results

Graphical relationships between mesh size (mesh opening, mesh bar, etc.) and internal diagonals (mesh size opening) are shown in Figure 12.3.2.1. On the basis of the standard trigonometric formulae relationships between "stretched mesh-size" and internal diagonals are reported in Figure 12.3.2.1. For practical reason, we will consider stretched mesh-size as "double mesh-bar" .

12.3.3 Discussion and conclusions

The main outcomes of the current analysis are:

- by fixing the minimum diagonal value (that is for example 16 mm), the minimum mesh size can be reached only at the squared mesh-opening (*β=45°* and mesh bar equal to 22.63 mm, see Table 4);
- the maximum internal area in a mesh is reached at the squared mesh-opening (*β=45°*, see Table 4);
- assuming that our interpretation of mesh size opening is coherent with the term reported in the Art. 9 of the EC Reg. 1967/2006 paragraph 6, should imply that *"Bottom-set gillnets shall not have a mesh size smaller than 22.63 mm"*.

Table 4 Different mesh openings with the *β* angle varying from 0° to 90°. The values of both the diagonals (2xb and 2xc), the stretched mesh size (2xa), and the area of the internal mesh (Area) are reported. As it can be seen only with *β*=45° both the diagonals are of the same value.

β[°]	2xc	2xb	2xa	Area
0	0.00	16.00	16.00	0
15	16.00	59.71	61.82	478
30	16.00	27.71	32.00	222
45	16.00	16.00	22.63	128
60	16.00	9.24	18.48	74
75	16.00	4.29	16.56	34
90	16.00	0.00	16.00	0

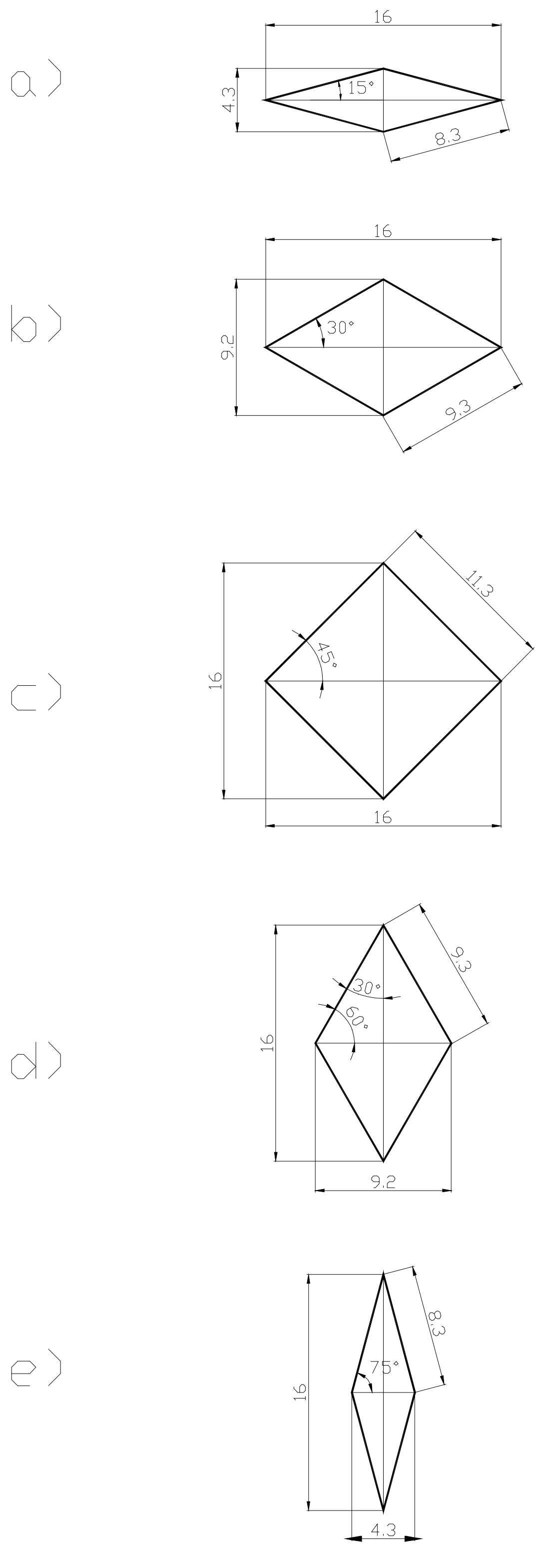


Figure 12.3.2.1 Different mesh openings with the β angle varying from 15° (a) to 75° (e). The values of both the diagonals and the mesh bar are reported. As it can be seen only with β=45° both the diagonals are of the same value. *The current example would give a graphical advise on the technical meaning of the "mesh size opening" concept (represented by the values of the internal diagonals) and the relation between stretched mesh-size and mesh size opening.*

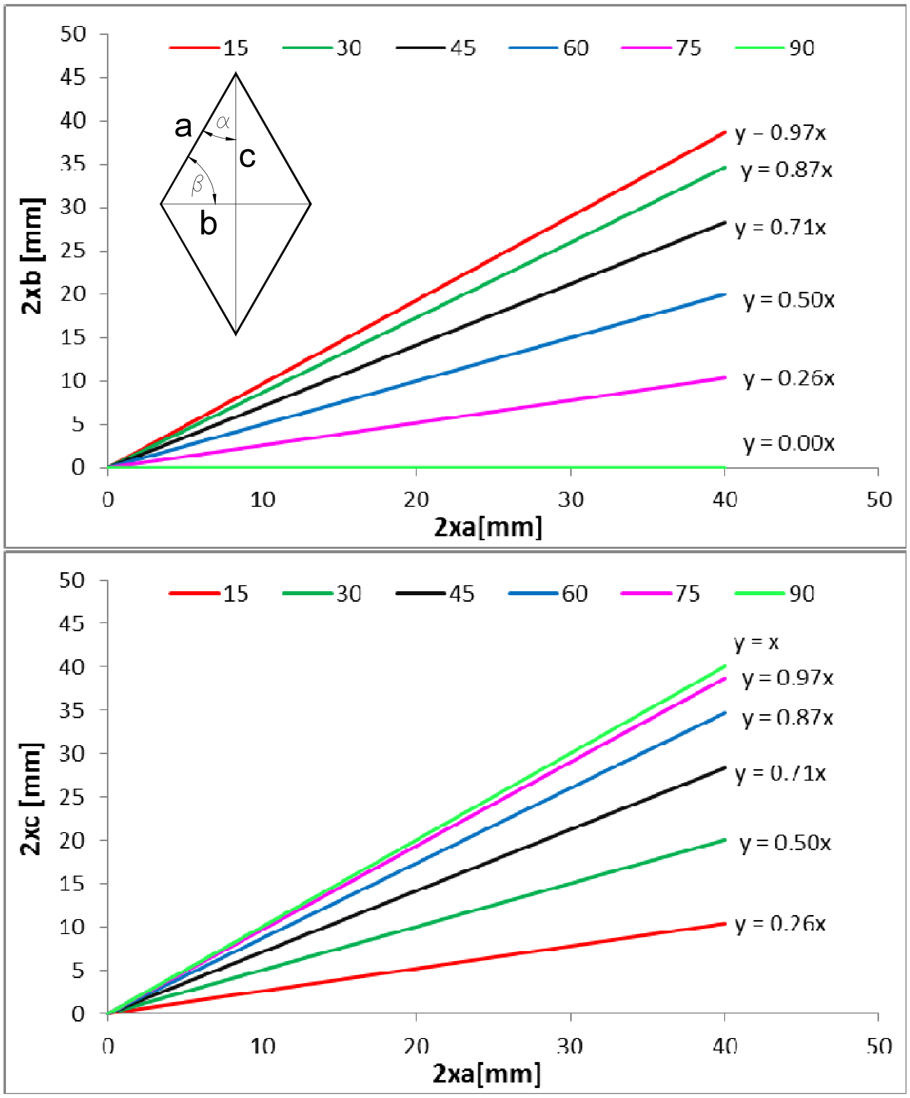


Figure 12.3.2.2 Relationships between stretched mesh-size (*2xa*) and internal diagonals (*2xb* and *2xc*). Curves represent different mesh openings with the β angle varying from 15° to 90°. For practical reason, we consider stretched mesh-size as "double mesh-bar".

12.4 Advise on the equivalent stretched mesh size for a knotted polyamide net of a mesh size opening of 16 mm and a thickness of 210/2 denier; provide a conversion factor between mesh size opening and stretched mesh size for such a type of net.

Theoretically, assuming that for a mesh size opening of 16 mm we intend the minimum diagonal value of 16 mm, there should be no effect of twine thickness on mesh size opening, which on the other way should affect the force needed to open a mesh. The theoretical conversion factor between mesh size opening and stretched mesh size for such type of net is equivalent to the other meshes (see § 12.3 above).

However, we are available for laboratory measurement of different nets having different mesh size opening around 16 mm and different twine thickness. Results will be available for the next STECF EWG meeting.

12.5 Explanation of the meaning and correlation among different ways of expressing the twine thickness (e.g. mm; denier, etc.).

12.5.1 Relevant referenced ISO standards

The following ISO standards can provide useful information for explaining the meaning of the different ways for expressing "twine thickness". There are also other standard ASTM, CEN, available upon request.

ISO 858:1973 Fishing nets - Designation of netting yarns in the Tex System.

As a general rule, netting yarns designated by their linear density or their resultant linear density are usually grey yarns without any preparation. Specifies general usage and complete designation and, for particular cases, brief designation. Three examples for designation are covered - Replaces ISO Recommendation R 858-1968.

ISO 1144:1973 Textiles - Universal system for designating linear density (Tex System).

Gives the principles and recommended units of the Tex System for the expression of linear density and includes conversion tables for calculation the Tex values of numbers or counts in other systems together with a statement of the procedure for the implementation of the Tex System in trade and industry. The Tex System is applicable to all kinds of textile fibres, intermediate products (e.g. tops, slivers and rovings), yarns and similar structures - Replaces ISO Recommendation R 1144-1969.

ISO 2947:1973 Textiles - Integrated conversion table for replacing traditional yarn numbers by rounded values in the Tex System.

This International Standard is intended to facilitate the changeover by industry and commerce from traditional yarn numbering systems to the Tex System. It provides a range of recommended rounded linear densities in the Tex System to replace the yarn numbers in the six main traditional numbering systems.

12.5.2 Relevant terminology and referenced tables of conversion

Practical, easy and complete information on correlation among different parameters as well as formulae, tables of conversion, and definitions can be found on FAO (1990).

Thickness. The distance between one surface and its opposite; the distance between the upper and lower surfaces of the material, measured under a specified pressure.

Linear density. *For fiber and yarn,* mass per unit length.

Denier. The unit of linear density, equal to the mass in grams of 9000 m of fiber, yarn, or other textile strand that is used in a direct yarn numbering system.

Tex. The unit of linear density, equal to the mass in grams of 1000 meters of fiber, yarn, or other textile strand, that is used in a direct yarn numbering system.

Direct yarn numbering system. A system that expresses the linear density of yarn in mass per unit length.

DISCUSSION - The preferred units of measurements for the direct yarn measuring system are grams and meters. Tex (weight in grams for 1000 metres) and Denier (weight in grams for 9000 metres) are recommended to show linear density in the direct numbering system. These can be calculated by dividing the mass of a yarn by its length. Conversion factors to convert between direct and indirect numbering systems can be found in Standard Tables ASTM-D2260.

12.5.3 References

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12.6 Assessment of Malta's Fisheries Management Plan 2011-2015

12.6.1 Introduction

The expert working group reviewed the Maltese fisheries management plan during the meeting of STECF EWG 11-12 as required by the Mediterranean Regulation (C.R. (EC) No1967/2006). A previous version of the of the Fisheries Management Plan (MP) was submitted by the Maltese authorities in 2009 and revised by the STECF in its Plenary Meeting in July 2009. STECF concluded that MP lacked appropriate data and information to permit an evaluation of its likely impact. According to STECF 2009 moreover, the MP had no clear objectives, no time frame to achieve the objectives and no harvest control rules specified. It also lacked any assessment of the status of the resources that the MP addresses. STECF 2009 identified a number of issues to be taken into account in the preparation of the MP, among others, catch data by fishery segment and species for the longest possible series of years, including trends and CPUE data when appropriate and available; discard rates; stock assessment for the target species or other useful stock indicators; identification of target management reference points to be achieved during the implementation of the MP.

12.6.2 General comments on the Malta's Fisheries Management Plan

The STECF EWG 11-12 noticed that the fisheries covered by the MP are: bottom otter trawlers, dolphinfish purse seiners, lampara, tartarum and gangmu. For each fishery, the following sections are presented: description, fleet structure and capacity, conservation status of the stocks and socio- economic characteristics of the fishery. The information provided for in these sections is quite different among fisheries.

- Priority is given to monitoring programs and stock assessments aiming to improve the information on the status of the stocks and to determine fishing impacts followed by functionality of the current management regime.
- The current characteristic of the fisheries included in the MP (characteristics of the fleet, activity, target species, landings by species) are well described.
- A major shortfall in the MP is that the status of the stocks is unknown for many of the target species. The assessments presented consider stocks with catches that represent only a small fraction of the overall national landings. Moreover, the current status of such stocks, depend few on the activity of the Maltese fleet, because these resources are shared with other countries. This fact creates many problems for identifying actions that the MP can carry out unilaterally, without any co-ordination with the other countries that exploit the mentioned resources. Other resources such as *Coryphaena* hippurus and tunas show a wide spatial distribution and also in these cases, management has to be co-ordinated with all the countries with fleets targeting such resources.

- In the case of bottom otter trawling, reference points ($F_{0.1}$) are defined for the shared stocks of *Parapenaeus longirostris, Merluccius merluccius, Aristaeomorpha foliacea, Mullus barbatus* and *Mulllus surmuletus*. In all cases, excepting *Mullus surmuletus*, these stocks are overexploited. *M. surmuletus* stock is fully exploited. The dolphinfish (*Coryphaena hippurus*) is one of the most important species for the economy of the Maltese fishing industry; no information is available on the status of the stock. As for the lampara fishery, information on the stock status is not available for the target species (*Scomber japonicus*, *Scomber scombrus*, *Alosa alosa/Alosa fallax*, *Trachurus trachurus*). Current total landings are low though (248 t and 116 t in 2009 and 2010 respectively, all species).

  The "tartarun" is a surrounding net targeting the transparent goby *Aphia minuta*. Available information on the functioning of this gear indicates that the surface area of *P. oceanica* exposed to "tartarun" gear is 1.1% of the *P. oceanica meadows* surrounding the Maltese Islands. No information is available on the conservation status of the *Aphia minuta* stock. The number of vessels increased from 6 in 2007 to 11 in 2010. At present 12 vessels are licensed to use this gear. It operates very close to the coast. Scientific knowledge confirms that the gear does not touch the *Posidonia* beds.

  The "gangmu" is a bag net or prawn dredge which is drawn along the sea-bed to catch prawns: *Processa* and *Palaemon* spp.. It is somewhat similar to a trawl net but of smaller dimensions, and has a metal frame as opposed to otter boards. The "gangmu" fishery supplies live bait for use in other fisheries. The total annual catch is estimated to be around 930 kg. The activity is limited to three months, from 1 November to 31 January, and is said to operate at 2-5 m depth dredging across *P. oceanica* meadows. Seven vessels use this gear. No scientific data are available on the impact on the communities and grounds affected by the activity of this gear (on the benthic communities, on the removal of plants, biodiversity, etc).The use of shrimp traps as an alternative fishing method to catch *Palaemon* spp. and *Processa* spp. will be investigated in collaboration with interested Maltese fishermen.

- The available information on the exploited stocks in the area was not completely reported and analysed in the plan (i.e. catch or CPUE trends, etc). Nevertheless such information is very useful considering the data shortage and can be potentially useful because it may show trends indicating improvement or worsening of the stocks status.

- The MP states that the Maltese fishing fleet was composed of 1097 professional vessels and 1,871 recreational vessels (paragraph 2 page 4). However, the future monitoring of recreational fishing is omitted. The monitoring of recreational fishing should be carried out along with the monitoring of commercial fishing. This is necessary for the assessment of stocks targeted both by the commercial and recreational fleets.

- The plan states that there is trawling at night in depths of between 50 and 150 meters where the bottom is hard and rocky (paragraph 3 page 8). Despite the vulnerability of these coastal rocky habitats, where fragile benthic animals usually live, no particular management actions are planned to reduce the impact of trawling on these sensitive habitats.

The STECF EWG also commented on the three derogations mentioned in the MP. These derogations are related to the use of a traditional boat seine ("tartarun"). The "tartarun fleet" consists of 12 vessels that operate concentrated in one bay. The target species is *Aphia minuta*. These fishing vessels operates within the 3 miles stripe where the species concentrate, using a mesh size lower that the allowed and includes as a by-catch an unspecified number of individuals of other species. No information is supplied on the status of the *Aphia* stock, nor is evaluated the impact of this fishery on the other accompanying species. Without such information, it is not possible to assess the sustainability of such activity.

A number of management measures are suggested in the MP. Nevertheless, there is no clear separation between which management measures should be addressed at the national (25 miles management zone) or the international level (GFCM). For instance, a limitation of maximum number of fishing days per year and closed seasons (paragraph 5.1). However it states that many of these measures will have to be negotiated at GFCM level and in particular with the governments of Tunisia, Libya, Italy and Cyprus.

Five Marine Protected Areas covering more than 18,000 hectares of marine environment have to date been declared, which protect over 80% of *Posidonia oceanica* habitats found in the Maltese Islands

EWG 11-12 also noticed that one of the current management actions was the designation of one site as a fishery restricted area in International Waters. Based on an investigation into the spatial distribution of commercially important demersal species a site suitable for designation as a fishery restricted area (FRA) has been suggested in International Waters (nursery and spawning areas *M. merluccius*, *M. barbatus, M. surmuletus and P. longirostris*). The FRA Study presented in annex. This proposal was presented to GFCM-SAC in 2010.

The EWG 11-12 remarked that the management plan for each fishery mainly consists on a proposal of improving the knowledge on the fisheries and status of the stocks through research projects and monitoring of the fishery. Such actions can be considered positive, but should be combined with actions aimed at a sustainable exploitation. This is particularly critical for those fisheries where according with the statements included in the plan, the involved stocks show signals of overexploitation, where it should be necessary to define actions in order to invert such situation. The same considerations apply for those fisheries (as example the "gangmu") that operate over particular grounds (i.e. *Posidonia* beds), an environment which is very sensitive to fishing operations and needs of a specific assessment of the impact of the activity.

12.6.3 Evaluation of economic aspects

The expert working group noticed that the management plan addresses the economic aspects through two categories of management measures proposed for implementation:

<u>Immediate additional management measures</u> are proposed to be put in place before the end of 2011 in continuity with the existing management measures. These measures are reported without any description of the potential effects from a socio-economic prospective. Fishing days limitations, closed seasons, scrapping programmes and other technical measures proposed for bottom otter trawlers would have a significant impact from an economic and social point of view. As well as the limitations of fishing days and the other potential measures proposed for vessels operating with "lampara" gear could have relevant effects on fisheries profitability and employment in the fisheries sector.

<u>Proposed future management measures</u> are reported including also objectives related to socio-economic aspects of the fisheries covered by the management plan. The management actions reported in this section are not related to what is generally classified as "management measure". Indeed, most of the management actions reported in the document are related to stock assessments, monitoring systems and research activities, which have not a direct impact on fleets and fisheries. As a consequence, it is not clear if these management actions should be subjected to an evaluation of the economic impact.

- Bottom Otter Trawlers: As reported in the Malta's Fisheries Management Plan (p. 53), first results on the impacts of the implementation of the 50 mm diamond mesh sizes on all Maltese trawlers will be available in 2013.
- Dolphinfish Purse Seiners: As reported in the Malta's Fisheries Management Plan (p. 58), an assessment of the socio-economic impacts of management measures will be available in 2015.
- Lampara Fishery: As reported in the Malta's Fisheries Management Plan (p. 61), an assessment of the socio-economic impacts of management measures will be available in 2017.
- Tartarun Fishery: As reported in the Malta's Fisheries Management Plan (p. 64), an assessment of the socio-economic impacts of management measures will be available in 2017.

12.6.4 Conclusions

STECF EWG 11-12 concluded that the information on stock status of the species targeted by the different fleets and on the impact of the fishing activity is limited. The EWG agreed with the priority given in the MP to monitoring programs and stock assessments.

The three derogations requested related with the use of a traditional boat seine (“tartarun”) targeting *Aphia minuta* affects at present 12 vessels licensed (in 2007 the number of vessels using this gear was 6), with an average size of 6.2 m and an average gross tonnage is 2;the gear is hauled by hand. It is estimated the “tartarun” to be used only over 1.1% of the *Posidonia* meadows. No information is given on the status of the stock. However EWG notes that this fishery is conducted within a limited area (i.e. one single bay) and during a limited part of the year (mid-June to end August)). Moreover, EWG noted that this gear is not allowed by Maltese legislation to touch the *Posidonia* beds and therefore may qualify for the derogation for this gear operating over Posidonia medows.

EWG 11-12 considered that the recreational fishery should be included in the monitoring in order to assess the impact of this activity.

The management plan reports that trawling is practised in rocky bottoms (50 - 150 m). The EWG highlighted the absence of information on the types of habitats impacted by this activity and no planned action is foreseen. This information should be provided to demonstrate that this fishery is not impacting protected habitats e.g. coralligenous assemblages.

The socio-economic impacts of the proposed management measures have not been evaluated. The EWG supported the provision of the proposed MP to include socio- economic evaluations of any planned measures.

12.7 Attempt of economic analysis of the EU Mediterranean fishing fleets at GFCM Sub-Area level

12.7.1 Introduction

A data call for the Mediterranean was launched to collect relevant information at GFCM GSA level. The data call included biological, transversal and economic data. Economic data collected within DCR and DCF are regularly analysed by a STECF sub-group to produce the Annual Economic Report (AER). For the AER, DCF data are requested, elaborated and analysed at MS level. The Mediterranean data call should allow to perform an economic analysis at GFCM GSA level. However, the availability of all data at this geographical level has to be verified. The approach followed in this document consists in replicating at GFCM GSA level the economic analysis regularly performed at MS level in the AER. Based on the structure of the last available AER, AER 2010, an attempt to estimate the same variables and indicators and produce similar outputs in terms of figures and tables has been pursued.

The analysis has been limited to the sub-areas of the Mediterranean countries which have provided economic data to the STECF EWG-11-12. These countries are Cyprus, Italy, Malta and Slovenia. However, the only country with a coastline falling in different sub-areas is Italy. Indeed, Cyprus, Malta and Slovenia correspond geographically with the GFCM GSA 25, 15 and 17 respectively. As an economic analysis for these countries is regularly provided in the AER, only the 7 Italian sub-areas have been analysed in this document.

Even though indicators have been estimated for each of the Italian sub-areas, comments on the availability of data and reasons explaining the cases of data unavailability are reported only in Chapter 1 on GFCM GSA 09, as the same comments can be extended to all sub-areas.

12.7.2 GFCM GSA 09

12.7.2.1 Fleet structure

The main variables used in the AER 2010 to analyse fleet structure are represented by the number of vessels, gross tonnage and engine power. All these variables have been requested and are available at GFCM GSA level. Trends in these variables for GFCM GSA 09 are reported in Fig. 12.7.2.1.1.

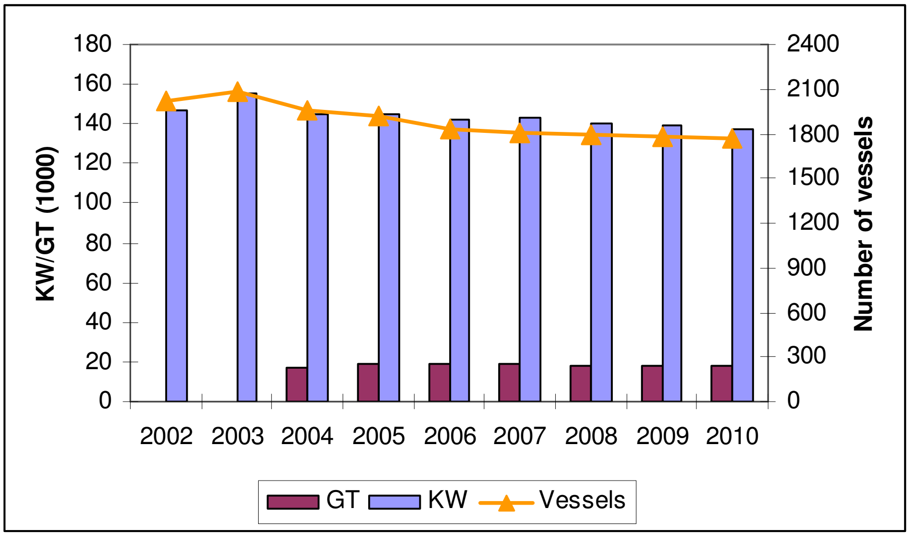

Figure 12.7.2.1.1 GFCM GSA 09 fleet capacity trends

An additional variable used to evaluate the fleet structure is represented by the average age of the fleet. Also this information has been requested and is available at GFCM GSA level. Trend in this variable for GFCM GSA 09 is reported in Fig. 12.7.2.1.2.

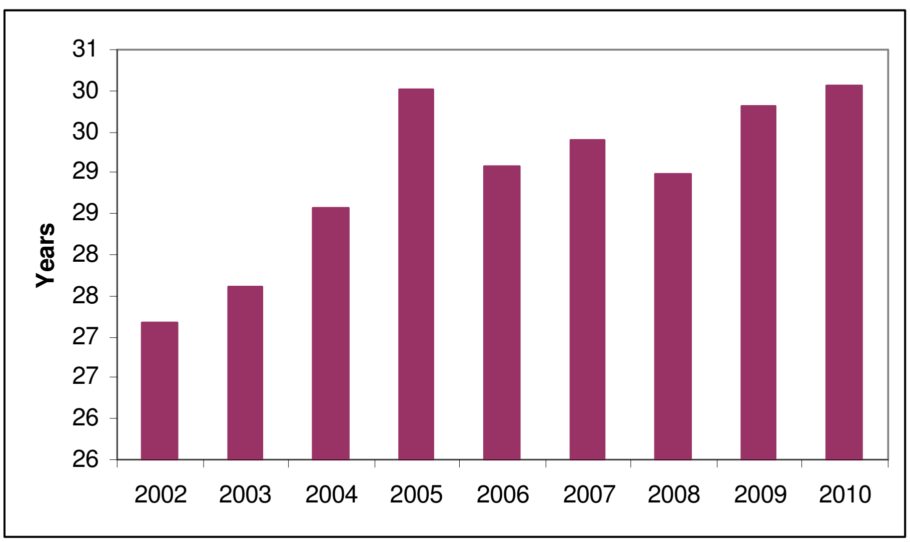

Figure 12.7.2.1.2 GFCM GSA 09 fleet age trend.

Another information used to have an overview of the fleet structure is the composition of fishing enterprises in terms of number of vessels owned. Unfortunately, this information has not been requested by the Mediterranean data call.

Figure 12.7.2.1.3 GFCM GSA 09 fishing enterprise categories in 2010 is not available.

From a social point of view, employment estimated in terms of total people employed and full time equivalents (FTE) represents the main descriptor of the fleet structure. Data on total employees has been requested and is available. On the contrary, data on FTE has been requested for the period 2002-2007. As a consequence, FTE in the period 2008-2010 is not available.

Figure 12.7.2.1.4 GFCM GSA 9 fleet employment trends

12.7.2.2 Fishing activity

Trends in fishing activity are analysed in the AER 2010 by using data on landings in weight, days at sea and fuel consumption. At GFCM GSA level, data on fuel consumption has been requested in the data call and is available (even if this data has not been submitted for 2010). On the contrary, data on days at sea has been requested just for the period 2008-2010 and landings data by fleet segment have not been requested in the Mediterranean data call. Available data are reported in Fig. 12.7.2.2.1.

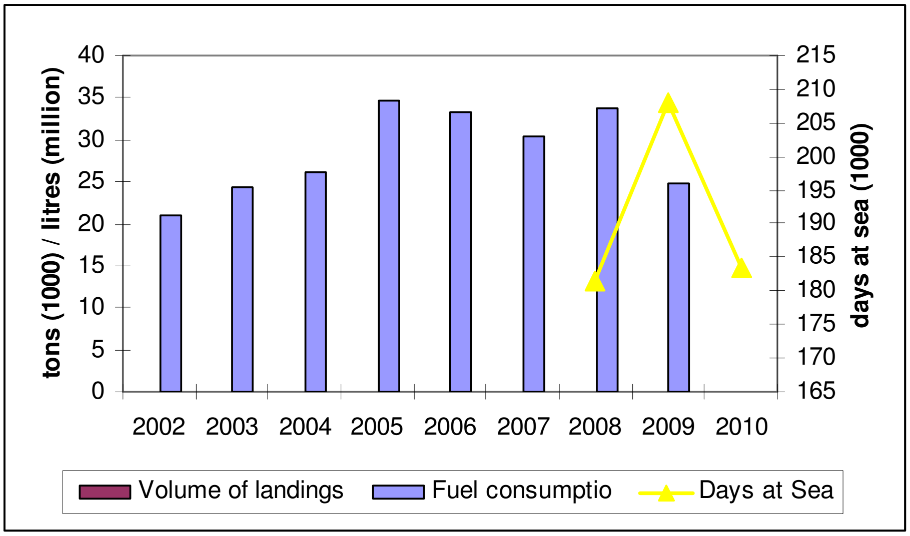

Figure 12.7.2.2.1 GFCM GSA 9 fleet days at sea, fuel use, volume landed trends

The 5 most relevant species in terms of landings weight are analysed in the AER 2010. Data on these species are available at GFCM GSA level just for 3 years, from 2008 to 2010, because the Mediterranean data call requested these data just for that period. A longer time series could be useful to identify trend in these variables. Furthermore, this data is not available by fleet segment, but by gear and Sub-Area. Data on top 5 species landed in GSCM GSA 09 are reported in Fig. 12.7.2.2.2.

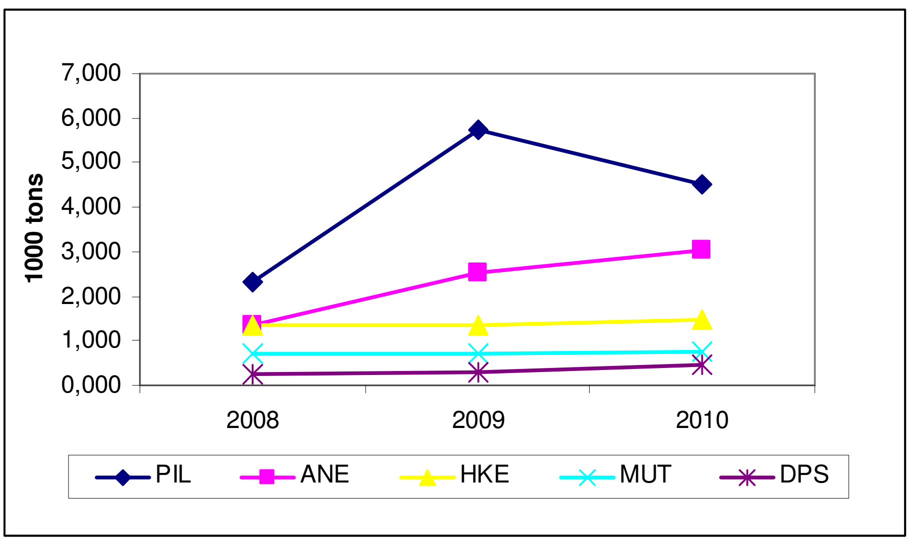

Figure 12.7.2.2.2 GFCM GSA 09 fleet top 5 species landed by volume trends

12.7.2.3 Economic performance

12.7.2.3.1 Landing values and prices

As reported above for the most relevant species in terms of landings weight, also data on the most important species in terms of landings value and price are available just for 3 years, from 2008 to 2010, as this period was requested in the Mediterranean data call. Data on species are available only by gear and, aggregating data by gear, by GFCM GSA. These data are not available by fleet segment as this was not requested in the data call. Trends on the data available are reported in Fig. 12.7.2.3.1.1 and 12.7.2.3.1.2.

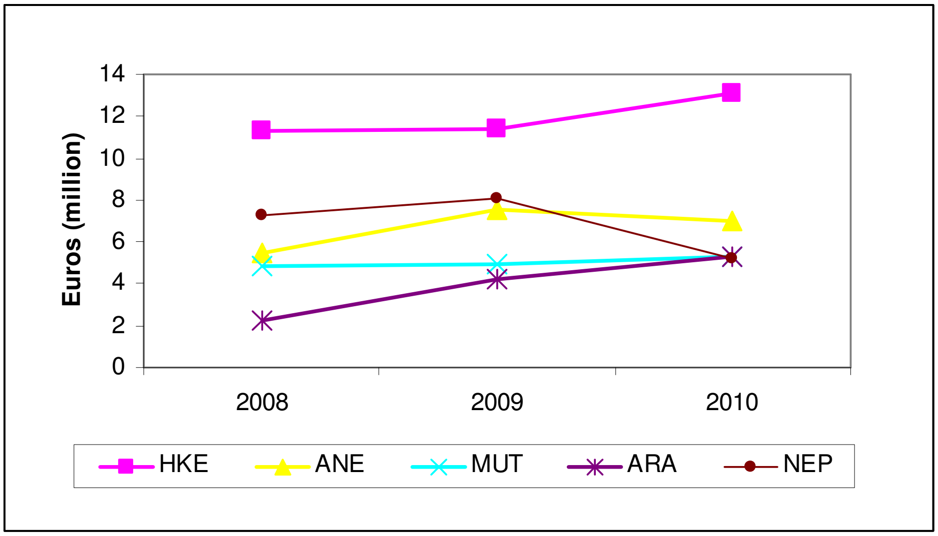

Figure 12.7.2.3.1.1 GFCM GSA 09 fleet top 5 species landed by value trends.

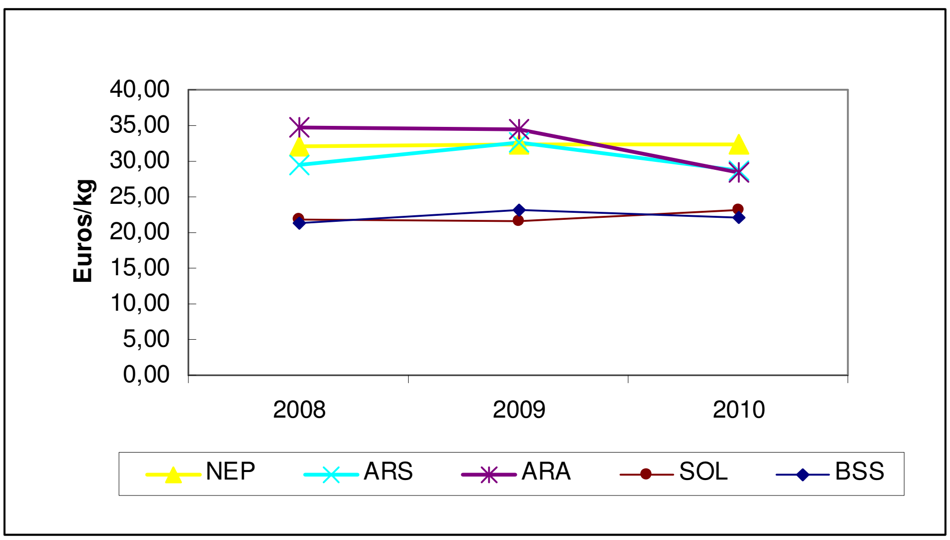

Figure 12.7.2.3.1.2 GFCM GSA 09 fleet price trends of top 5 species landed by value.

12.7.2.3.2 Income

The AER 2010 have analysed fleet costs, earnings and profitability by MS reporting a table with the most relevant economic variables and indicators collected within the DCF for years 2006-2008. The same information for the year 2010 is reported for GFCM GSA 09 in Tab. 12.7.2.3.2.1. Some data are not available for 2010 as these needs a longer time to be collected and elaborated after the reference period. As a consequence, these data were not available at the date of the data call. Indeed, AER 2010 reported data until 2008.

Table 12.7.2.3.2.1 GFCM GSA 09 fleet costs, earnings and profitability 2010

	Total (million euros)	% of total income
INCOME		
Value of landings	122,51	100%
Income from fishing rights	0,00	0%
Direct subsidies	n.a.	
Other income	0,00	0%
TOTAL INCOME*	122,51	100%
EXPENDITURE		
Energy (fuel) costs	28,66	23%
Repair costs	5,06	4%
Variable costs	13,24	11%
Non variable costs	4,80	4%
Expenditure on fishing rights	0,00	0%
Crew wages	34,01	28%
OPERATING CASH FLOW (OCF)	36,75	30%
Unpaid value of labour	0,00	0%
Depreciation	n.a.	
Interest (opportunity cost of capital)	n.a.	
ECONOMIC PROFIT / LOSS	n.a.	
GROSS VALUE ADDED (GVA)	70,76	58%
TANGIBLE ASSESTS VALUE	n.a.	
RETURN ON FIXED TANGIBLE ASSETS	n.a.	
FISHING RIGHTS VALUE	0,00	

* Direct subsidies are not included.

12.7.2.3.3 Expenditure

Data on expenditure are available and reported in Tab. 12.7.2.3.2.1.

Data on income, gross cash flow (GCF) and gross value added (GVA) are available and reported both in Tab. 12.7.2.3.2.1 and in Fig. 12.7.2.3.3.1 for trend analysis. On the contrary, profit or loss cannot be properly estimated as data on depreciation and interest are not available for 2010.

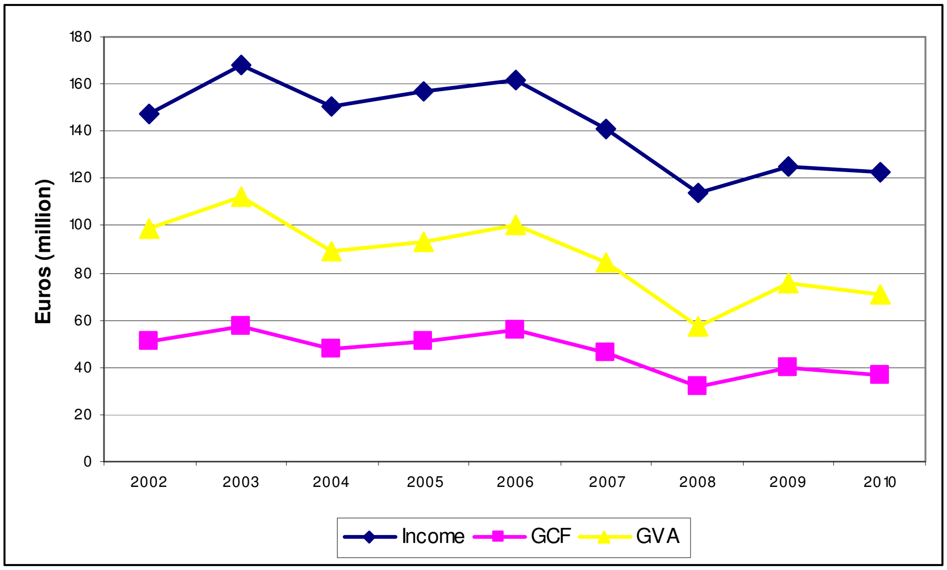

Figure 12.7.2.3.3.1 GFCM GSA 09 fleet key economic performance indicators.

12.7.2.3.4 Profitability

The analysis of profitability is mainly based on indicators reported in Fig. 12.7.2.3.3.1. The availability of these indicators at GFCM GSA level is discussed in the previous paragraph.

12.7.2.4 Fleet composition

Fleet composition is analysed in the AER 2010 by using 12 indicators estimated for each of the fleet segments active in the European countries. The identification of the fleet segments at GFCM GSA level has been possible and these are listed in Tab. 12.7.2.4.1 As regards indicators, just 6 indicators were possible to be estimated by the data set provided to the STECF EWG 11-12. Other 6 indicators were not estimated for different reasons. FTE was not requested by the Mediterranean data call for the last 3 years. As a consequence, also the average wage per FTE was is not available. The volume of landings by fleet segment was not requested by the Mediterranean data call. Other variables, even when requested, were not provided by MS as they were not yet available at the date of the data call. This is the case of direct subsidies and other variables to be used for the estimation of profit and capital value.

Tab. 12.7.2.4.1 GFCM GSA 09 fleet composition and key indicators in 2010

Fleet segment	Number of vessels	FTEs	Days at Sea (1000 days)	Volume of landings (1000 tons)	Value of landings (million euros)	Direct subsidies (million euros)	Total Income (million euros)	Average wage per FTE (euros)	GVA (million euros)	Operating cash flow (million euros)	Profit / loss (million euros)	Capital Value (million euros)
DRB VL1218	22		2,2		1,2		1,2		0,9	0,4		
DTS VL0612	25		2,7		1,9		1,9		1,0	0,5		
DTS VL1218	145		22,0		22,5		22,5		12,9	6,5		
DTS VL1824	157		26,6		40,1		40,1		18,5	9,1		
DTS VL2440	8		1,2		2,2		2,2		0,8	0,4		
PGP VL0006	322		19,4		4,1		4,1		3,0	1,6		
PGP VL0612	976		95,5		28,2		28,2		17,2	8,9		
PGP VL1218	77		9,5		11,4		11,4		9,2	5,8		
PS VL1218	13		1,0		1,9		1,9		1,3	0,6		
PS VL1824	9		0,8		2,6		2,6		1,9	0,8		
PS VL2440	20		2,4		6,3		6,3		4,1	2,0		

12.7.3 GFCM SA 10

12.7.3.1 Fleet structure

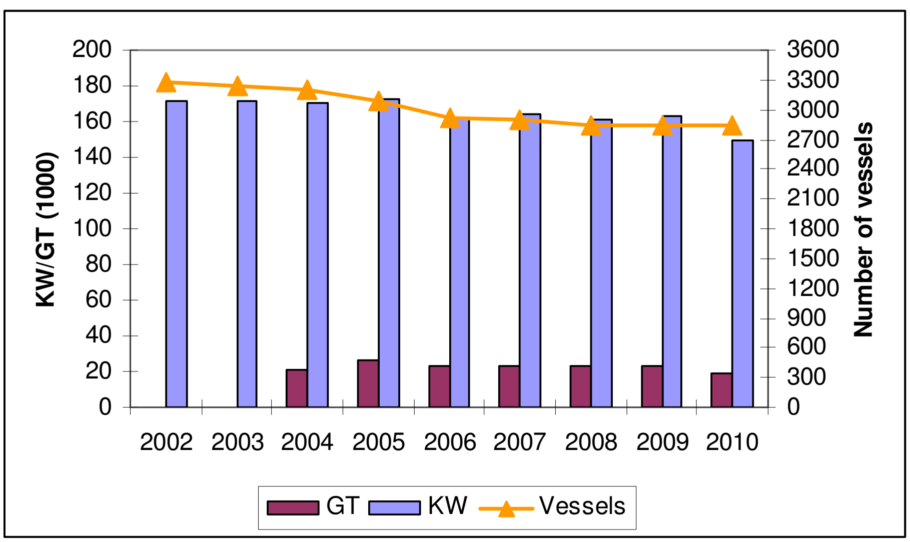

Figure 12.7.3.1.1 GFCM GSA 10 fleet capacity trends

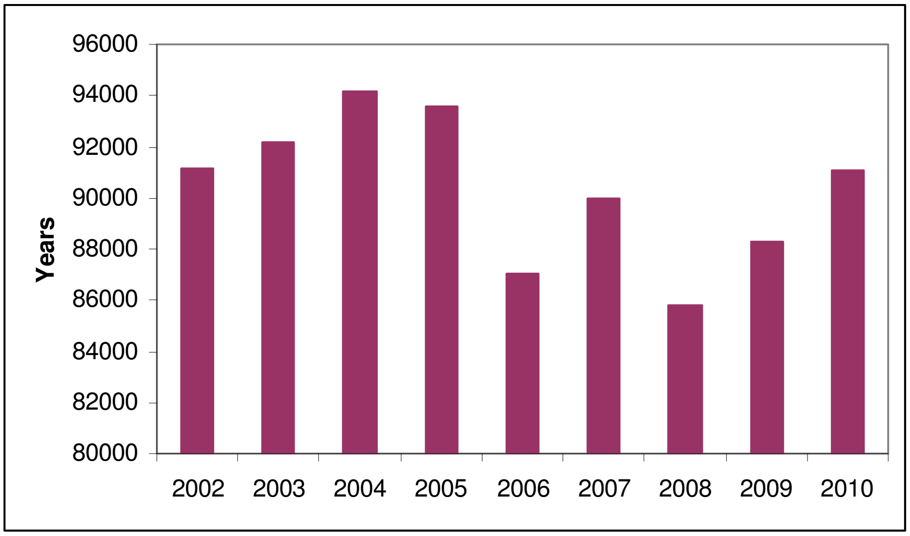

Figure 12.7.3.1.2 GFCM GSA 10 fleet age trend.

Figure 12.7.3.1.3 GFCM GSA 10 fishing enterprise categories in 2010 is not available.

Figure 12.7.3.1.4 GFCM GSA 10 fleet employment trends

12.7.3.2 Fishing activity

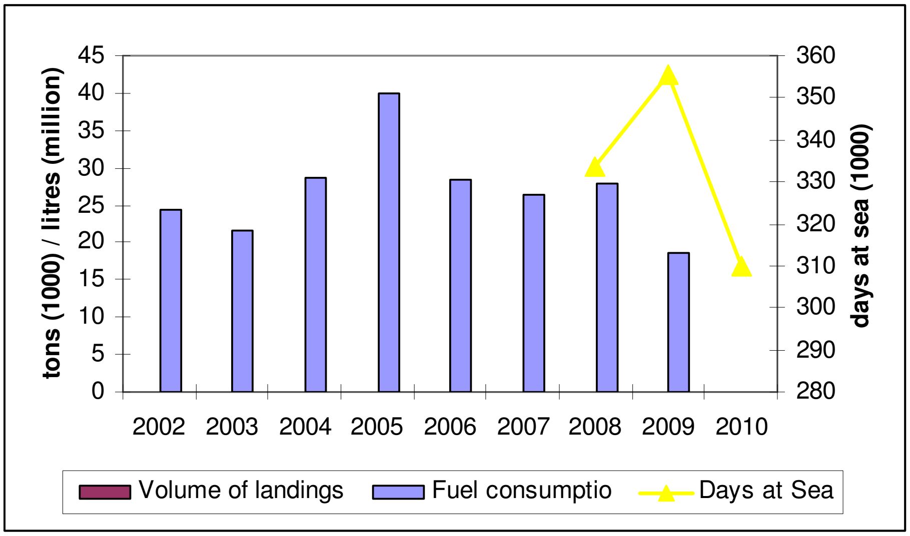

Figure 12.7.3.2.1 GFCM GSA 10 fleet days at sea, fuel use and volume landed trends

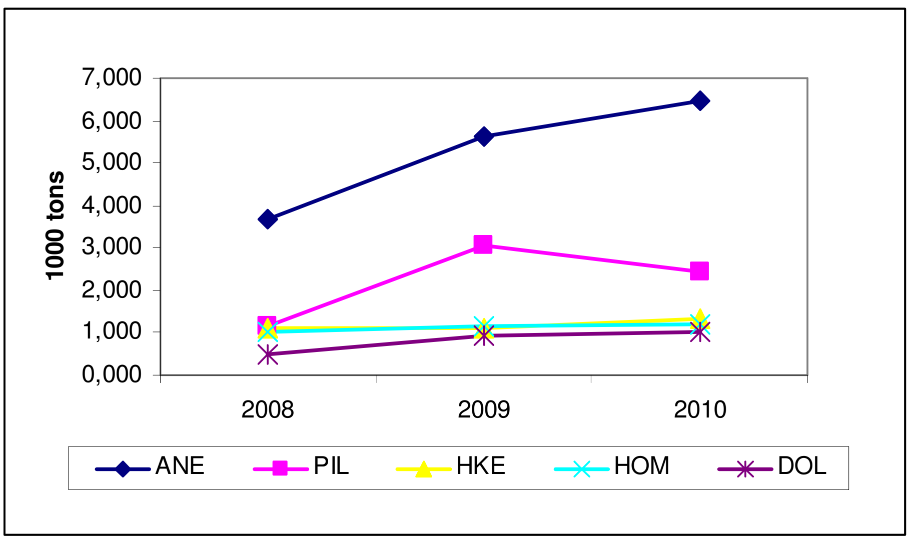

Figure 12.7.3.2.2 GFCM GSA 10 fleet top 5 species landed by volume trends

12.7.3.3 Economic performance

12.7.3.3.1 Landing values and prices

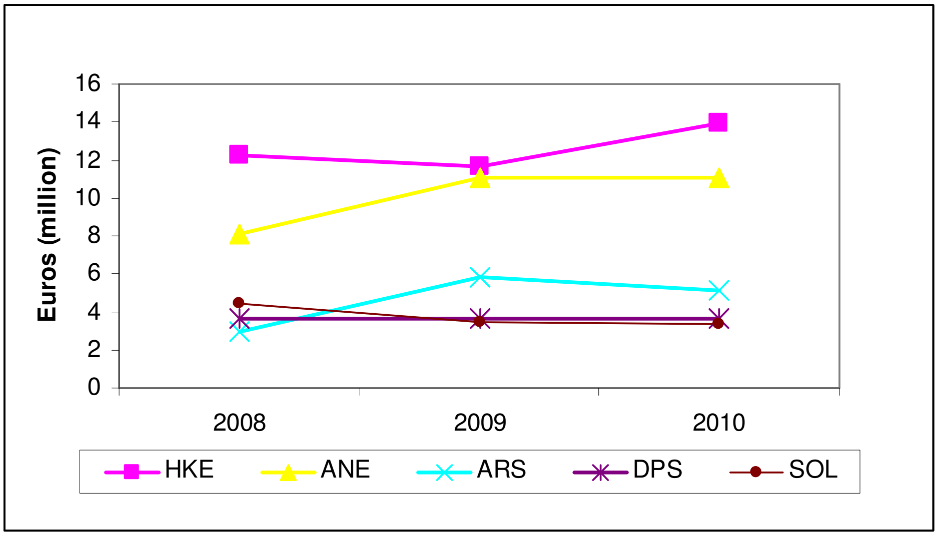

Figure 12.7.3.3.1.1 GFCM GSA 10 fleet top 5 species landed by value trends

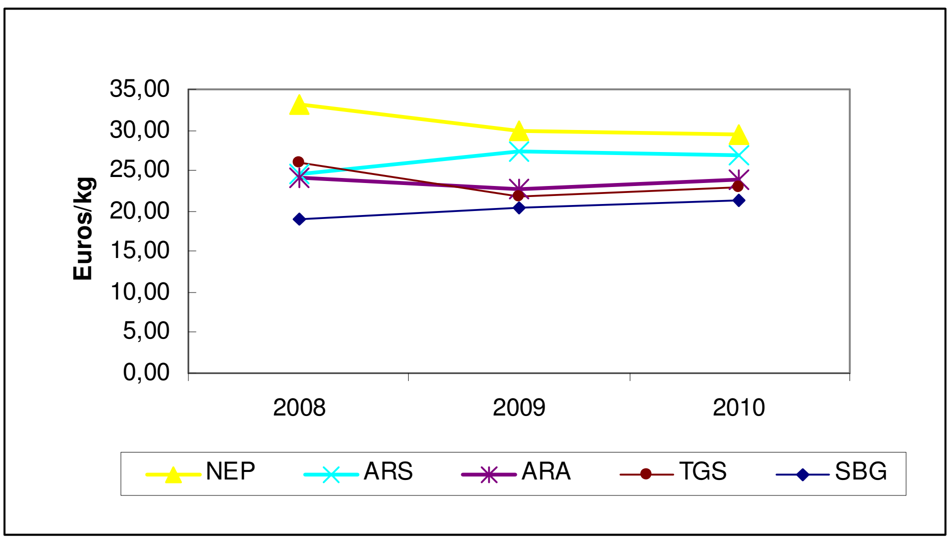

Figure 12.7.3.3.1.2 GFCM GSA 10 fleet price trends of top 5 species landed by value

12.7.3.3.2 Income

Table 12.7.3.3.2.1 GFCM GSA 10 fleet costs, earnings and profitability 2010

	Total (million euros)	% of total income
INCOME		
Value of landings	132,98	100%
Income from fishing rights	0,00	0%
Direct subsidies	n.a.	
Other income	0,00	0%
TOTAL INCOME	132,98	100%
EXPENDITURE		
Energy (fuel) costs	19,52	15%
Repair costs	7,33	6%
Variable costs	16,05	12%
Non variable costs	4,92	4%
Expenditure on fishing rights	0,00	0%
Crew wages	41,73	31%
OPERATING CASH FLOW (OCF)	43,42	33%
Unpaid value of labour	0,00	0%
Depreciation	n.a.	
Interest (opportunity cost of capital)	n.a.	
ECONOMIC PROFIT / LOSS	n.a.	
GROSS VALUE ADDED (GVA)	85,16	64%
TANGIBLE ASSESTS VALUE	n.a.	
RETURN ON FIXED TANGIBLE ASSETS	n.a.	
FISHING RIGHTS VALUE	0,00	

* Direct subsidies is not included.

12.7.3.3.3 Expenditure

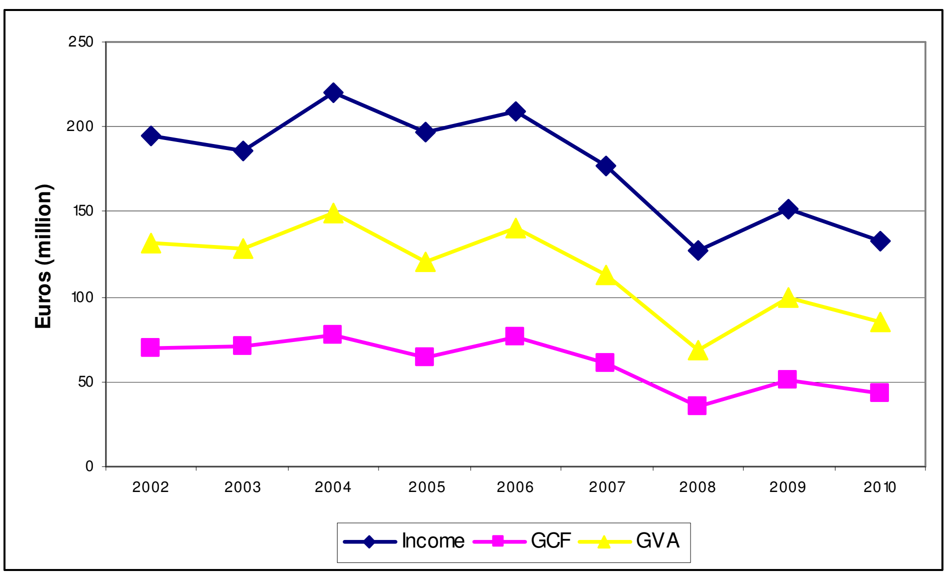

Figure 12.7.3.3.3.1 GFCM GSA 10 fleet key economic performance indicators

12.7.3.3.4 Profitability

12.7.3.4 Fleet composition

Table 12.7.3.4.1 GFCM GSA 10 fleet composition and key indicators in 2010

Fleet segment	Number of vessels	FTEs	Days at Sea (1000 days)	Volume of landings (1000 tons)	Value of landings (million euros)	Direct subsidies (million euros)	Total Income (million euros)	Average wage per FTE (euros)	GVA (million euros)	Operating cash flow (million euros)	Profit / loss (million euros)	Capital Value (million euros)
DRB VL1218	14		1,4		1,0		1,0		0,7	0,4		
DTS VL0612	13		1,9		1,1		1,1		0,6	0,3		
DTS VL1218	158		20,7		21,6		21,6		13,3	6,9		
DTS VL1824	79		9,3		16,5		16,5		8,9	4,0		
HOK VL1218	25		2,1		3,2		3,2		1,7	0,6		
PGP VL0006	737		67,4		10,3		10,3		6,9	3,2		
PGP VL0612	1527		179,8		46,3		46,3		31,2	16,8		
PGP VL1218	128		13,9		11,1		11,1		7,5	4,8		
PMP VL0612	14		1,2		0,9		0,9		0,4	0,2		
PMP VL1218	53		5,5		4,8		4,8		2,6	1,4		
PS VL1218	61		5,0		8,2		8,2		5,7	2,5		
PS VL1824	28		1,8		7,9		7,9		5,8	2,6		
PS VL2440	9		0,0		0,0		0,0		-0,2	-0,2		

12.7.4 GFCM GSA 11

12.7.4.1 Fleet structure

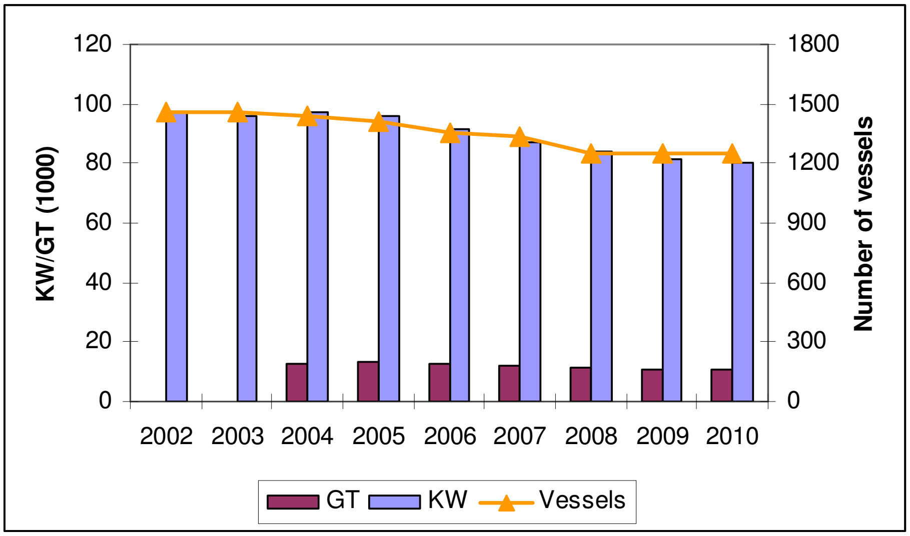

Figure 12.7.4.1.1 GFCM GSA 11 fleet capacity trends.

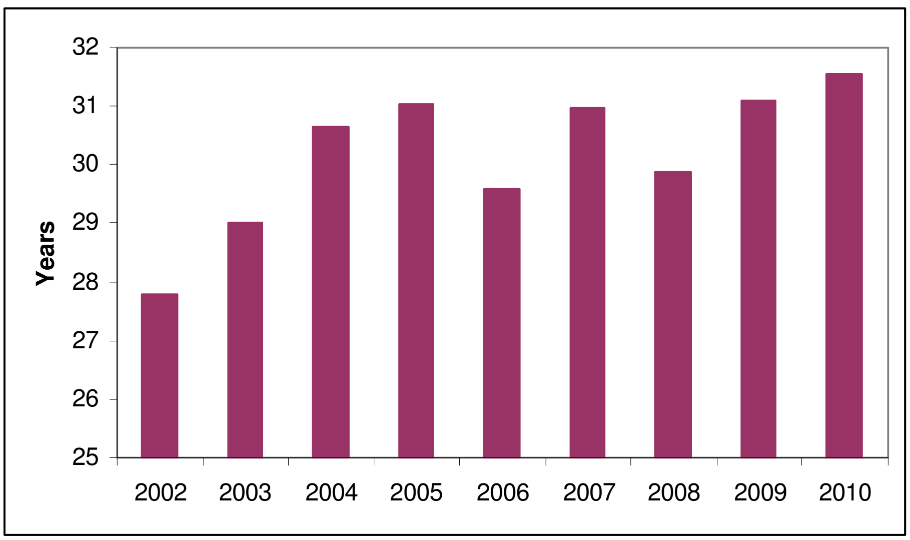

Figure 12.7.4.1.2 GFCM GSA 11 fleet age trend.

Figure 12.7.4.1.3 GFCM GSA 11 fishing enterprise categories in 2010 is not available.

Figure 12.7.4.1.4 GFCM GSA 11 fleet employment trends.

12.7.4.2 Fishing activity

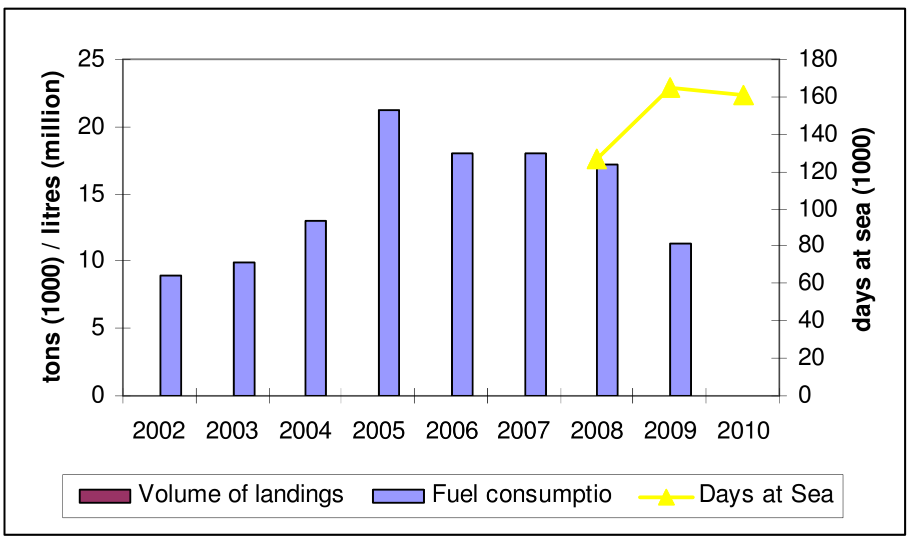

Figure 12.7.4.2.1 GFCM GSA 11 fleet days at sea, fuel use, volume landed trends

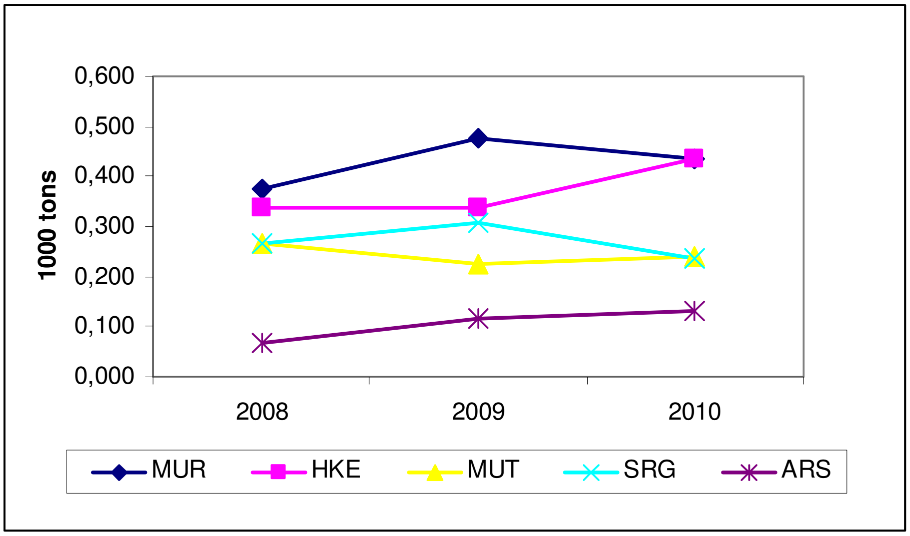

Figure 12.7.4.2.2 GFCM GSA 11 fleet top 5 species landed by volume trends

12.7.4.3 Economic performance

12.7.4.3.1 Landing values and prices

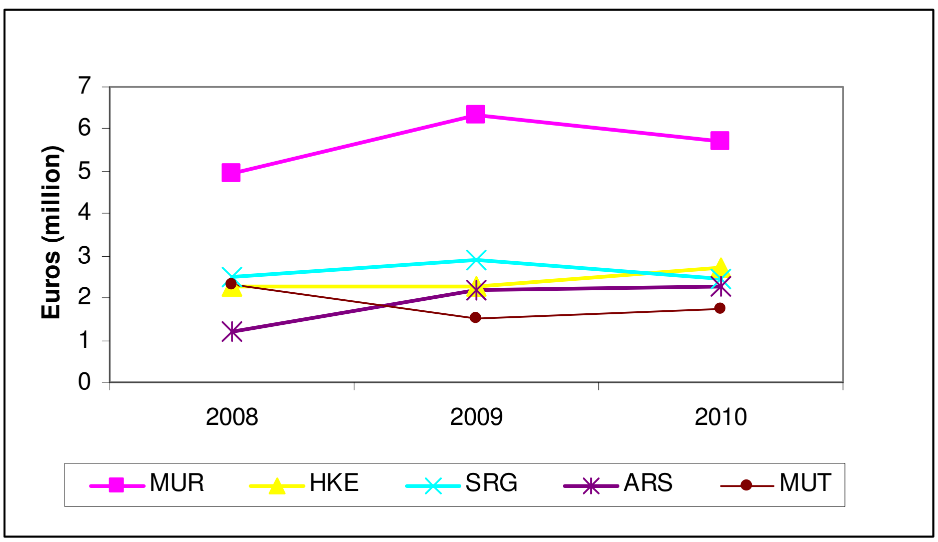

Figure 12.7.4.3.1.1 GFCM GSA 11 fleet top 5 species landed by value trends

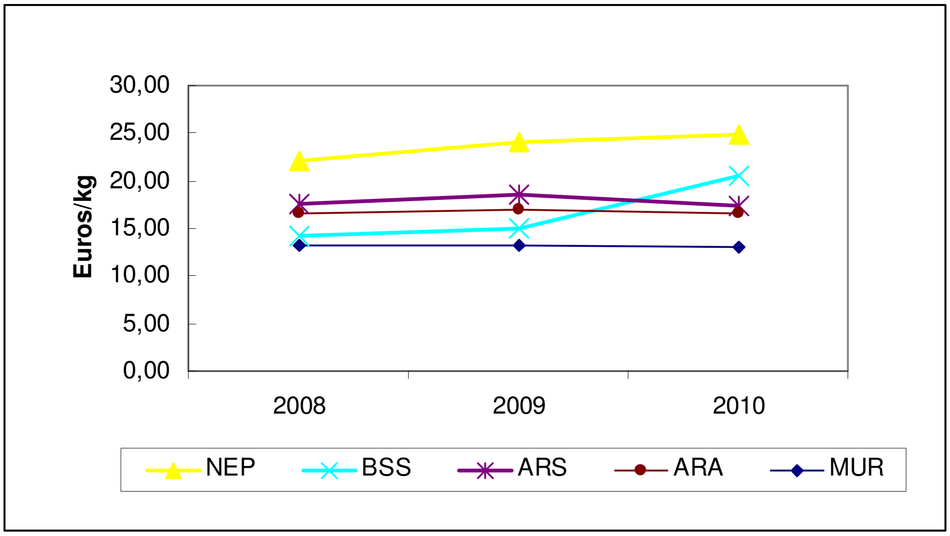

Figure 12.7.4.3.1.2 GFCM GSA 11 fleet price trends of top 5 species landed by value

12.7.4.3.2 Income

Table 12.7.4.3.2.1 GFCM GSA 11 fleet costs, earnings and profitability 2010

	Total (million euros)	% of total income
INCOME		
Value of landings	62,73	100%
Income from fishing rights	0,00	0%
Direct subsidies	n.a.	
Other income	0,00	0%
TOTAL INCOME	62,73	100%
EXPENDITURE		
Energy (fuel) costs	13,11	21%
Repair costs	3,25	5%
Variable costs	9,09	14%
Non variable costs	2,58	4%
Expenditure on fishing rights	0,00	0%
Crew wages	16,45	26%
OPERATING CASH FLOW (OCF)	18,26	29%
Unpaid value of labour	0,00	0%
Depreciation	n.a.	
Interest (opportunity cost of capital)	n.a.	
ECONOMIC PROFIT / LOSS	n.a.	
GROSS VALUE ADDED (GVA)	34,71	55%
TANGIBLE ASSESTS VALUE	n.a.	
RETURN ON FIXED TANGIBLE ASSETS	n.a.	
FISHING RIGHTS VALUE	0,00	

* Direct subsidies is not included.

12.7.4.3.3 Expenditure

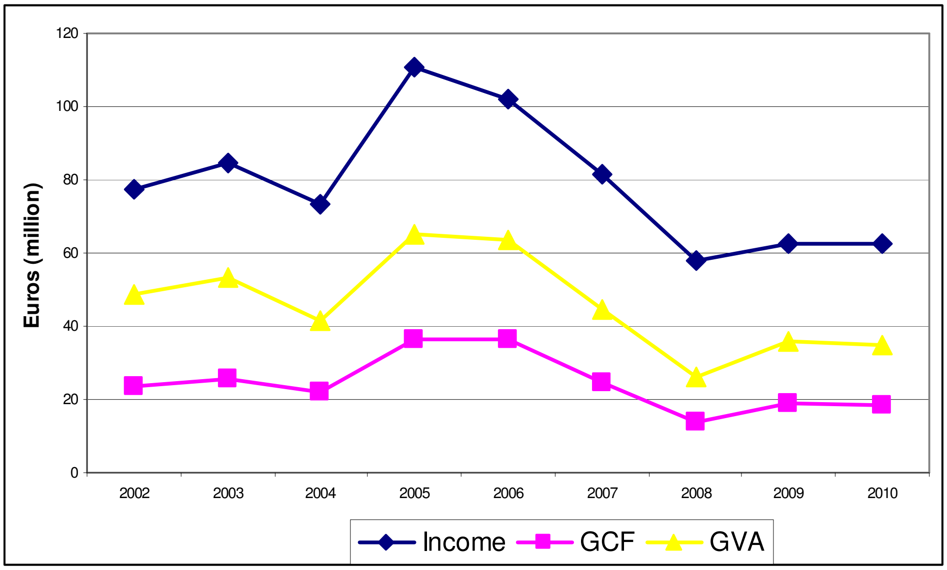

Figure 12.7.4.3.3.1 GFCM GSA 11 fleet key economic performance indicators

12.7.4.3.4 Profitability

12.7.4.4 Fleet composition

Table 12.7.4.4.1 GFCM GSA 11 fleet composition and key indicators in 2010

Fleet segment	Number of vessels	FTEs	Days at Sea (1000 days)	Volume of landings (1000 tons)	Value of landings (million euros)	Direct subsidies (million euros)	Total Income (million euros)	Average wage per FTE (euros)	GVA (million euros)	Operating cash flow (million euros)	Profit / loss (million euros)	Capital Value (million euros)
DTS VL0612	13		2,4		1,0		1,0		0,6	0,2		
DTS VL1218	66		8,7		6,2		6,2		3,6	1,4		
DTS VL1824	32		4,3		5,2		5,2		2,3	1,1		
DTS VL2440	26		3,9		7,9		7,9		3,2	1,4		
PGP VL0006	245		27,8		6,8		6,8		4,7	2,8		
PGP VL0612	755		99,6		24,3		24,3		12,8	6,9		
PGP VL1218	114		14,1		11,3		11,3		7,5	4,5		

12.7.5 GFCM GSA 16

12.7.5.1 Fleet structure

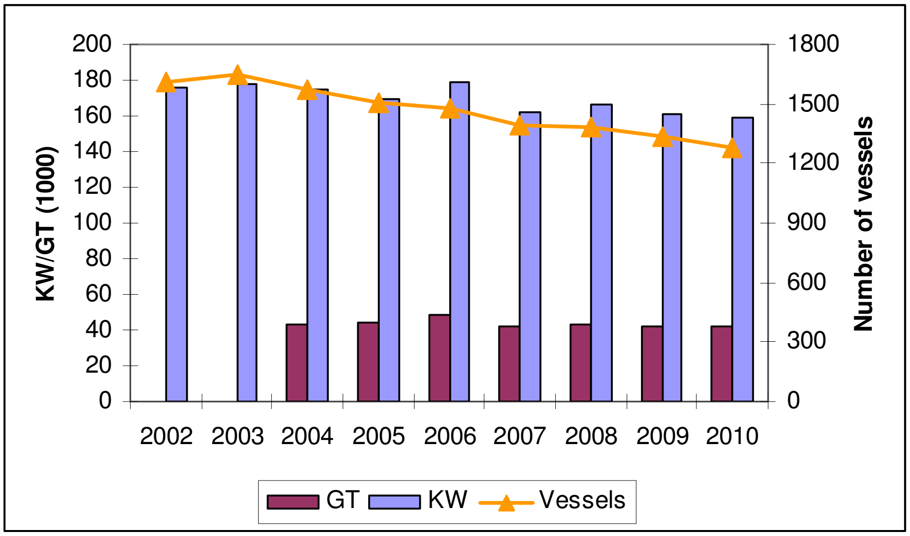

Figure 12.7.5.1.1 GFCM GSA 16 fleet capacity trends

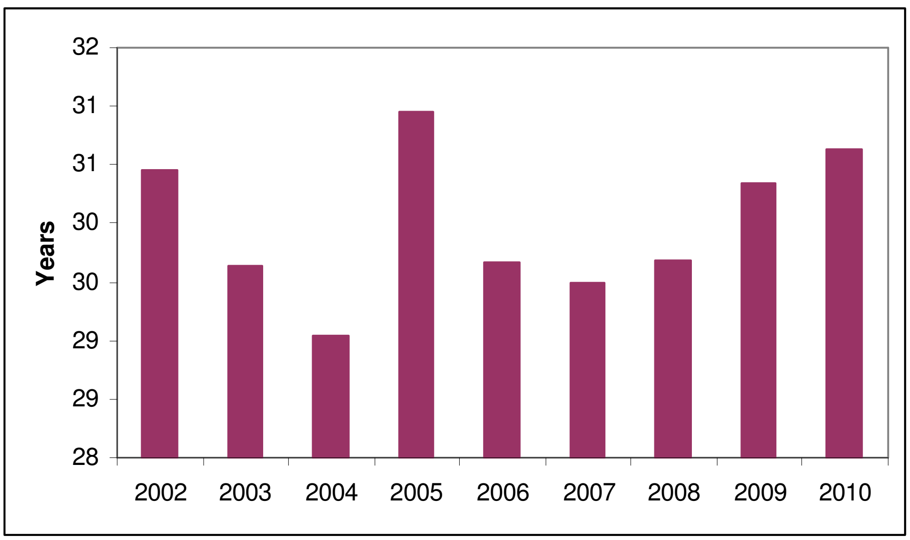

Figure 12.7.5.1.2 GFCM GSA 16 fleet age trend

Figure 12.7.5.1.3 GFCM GSA 16 fishing enterprise categories in 2010 is not available.

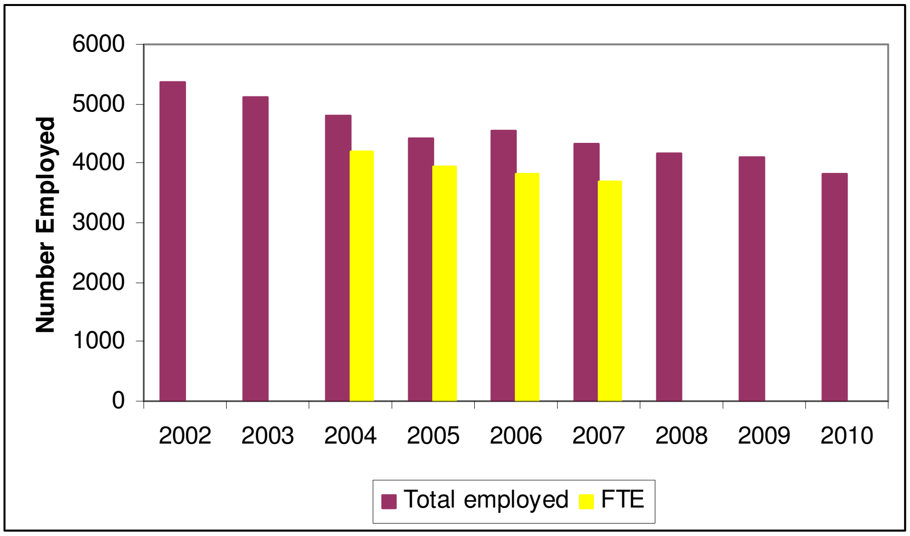

Figure 12.7.5.1.4 GFCM GSA 16 fleet employment trends

12.7.5.2 Fishing activity

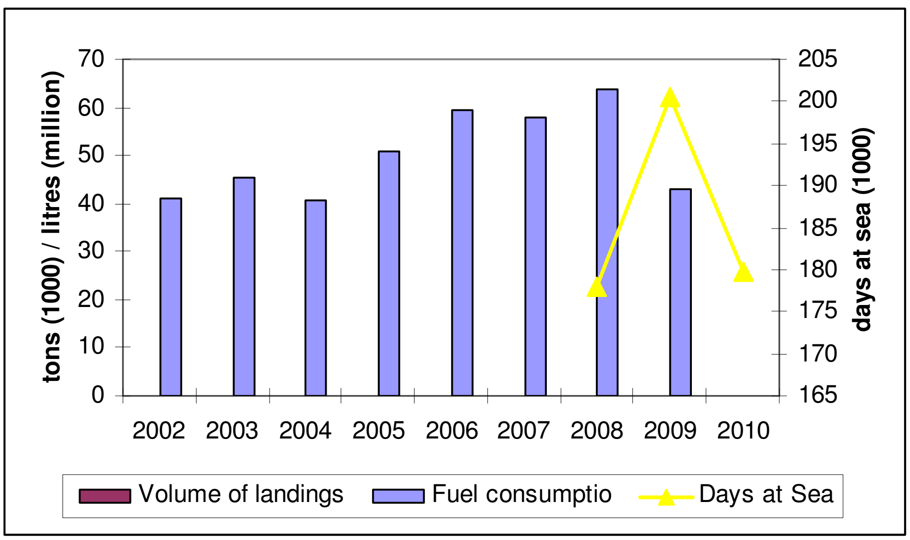

Figure 12.7.5.2.1 GFCM GSA 16 fleet days at sea, fuel use, volume landed trends

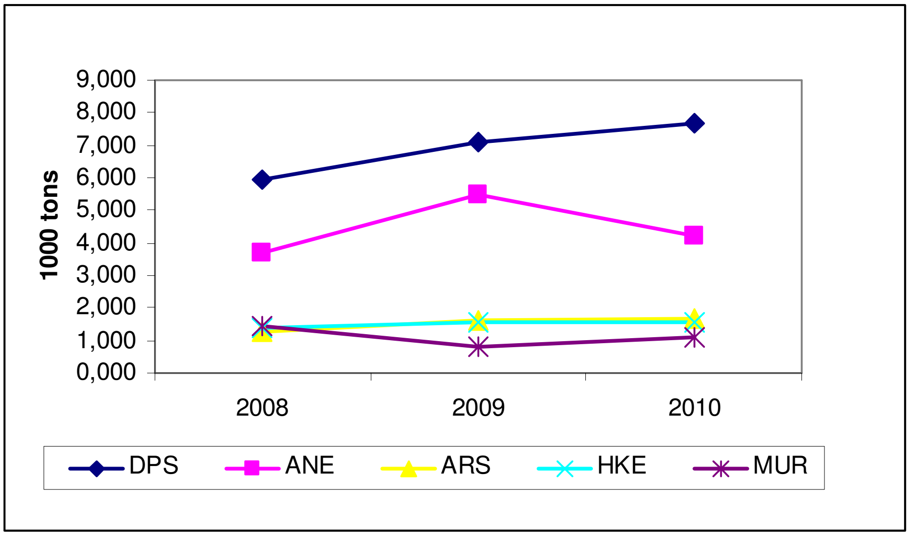

Figure 12.7.5.2.2 GFCM GSA 16 fleet top 5 species landed by volume trends

12.7.5.3 Economic performance

12.7.5.3.1 Landing values and prices

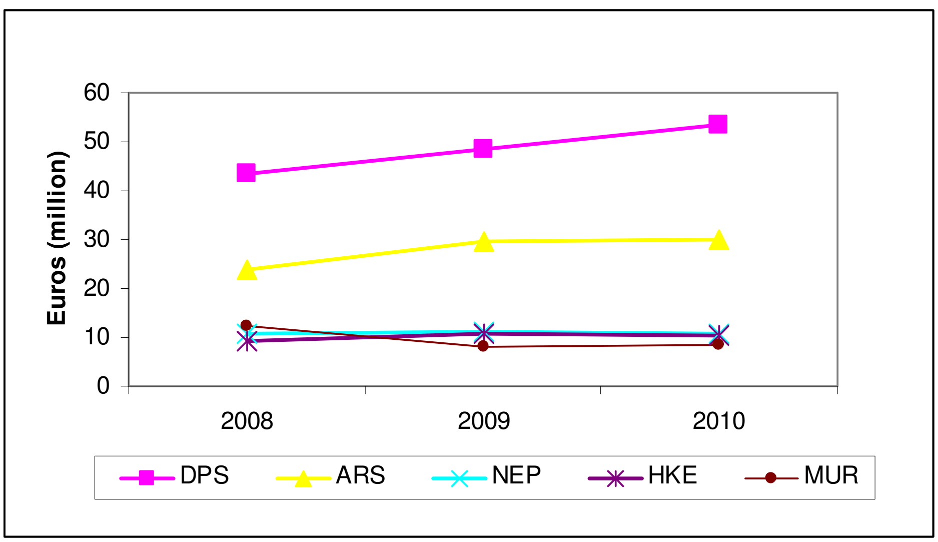

Figure 12.7.5.3.1.1 GFCM GSA 16 fleet top 5 species landed by value trends

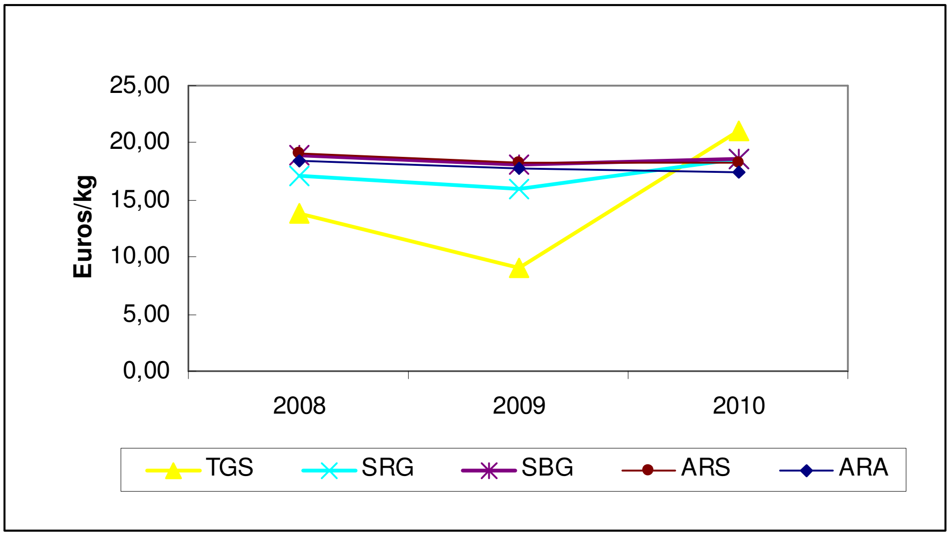

Figure 12.7.5.3.1.2 GFCM GSA 16 fleet price trends of top 5 species landed by value

12.7.5.3.2 Income

Table 12.7.5.3.2.1 GFCM GSA 16 fleet costs, earnings and profitability 2010

	Total (million euros)	% of total income
INCOME		
Value of landings	194,57	100%
Income from fishing rights	0,00	0%
Direct subsidies	n.a.	
Other income	0,00	0%
TOTAL INCOME	194,57	100%
EXPENDITURE		
Energy (fuel) costs	52,16	27%
Repair costs	8,38	4%
Variable costs	29,00	15%
Non variable costs	9,13	5%
Expenditure on fishing rights	0,00	0%
Crew wages	49,59	25%
OPERATING CASH FLOW (OCF)	46,31	24%
Unpaid value of labour	0,00	0%
Depreciation	n.a.	
Interest (opportunity cost of capital)	n.a.	
ECONOMIC PROFIT / LOSS	n.a.	
GROSS VALUE ADDED (GVA)	95,90	49%
TANGIBLE ASSESTS VALUE	n.a.	
RETURN ON FIXED TANGIBLE ASSETS	n.a.	
FISHING RIGHTS VALUE	0,00	

* Direct subsidies is not included.

12.7.5.3.3 Expenditure

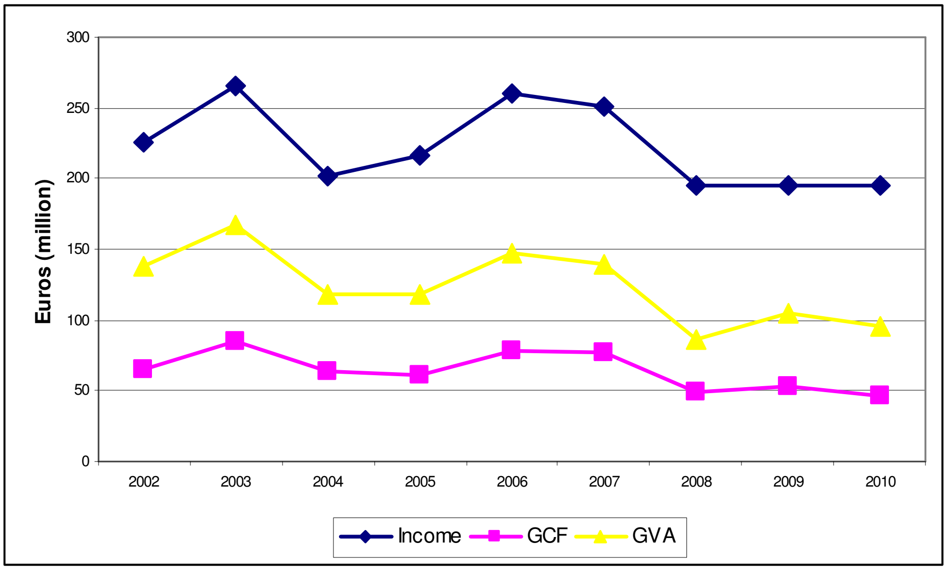

Figure 12.7.5.3.3.1 GFCM GSA 16 fleet key economic performance indicators

12.7.5.3.4 Profitability

12.7.5.4 Fleet composition

Table 12.7.5.4.1 GFCM GSA 16 fleet composition and key indicators in 2010

Fleet segment	Number of vessels	FTEs	Days at Sea (1000 days)	Volume of landings (1000 tons)	Value of landings (million euros)	Direct subsidies (million euros)	Total Income (million euros)	Average wage per FTE (euros)	GVA (million euros)	Operating cash flow (million euros)	Profit / loss (million euros)	Capital Value (million euros)
DTS VL0612	17		2,5		2,0		2,0		1,3	0,6		
DTS VL1218	143		22,9		24,6		24,6		13,3	6,9		
DTS VL1824	163		27,4		44,0		44,0		19,4	10,5		
DTS VL2440	154		28,4		69,2		69,2		25,3	9,5		
HOK VL1218	31		3,3		8,2		8,2		5,9	3,0		
HOK VL1824	15		2,2		8,9		8,9		6,4	3,3		
PGP VL0006	204		22,1		4,6		4,6		3,4	1,8		
PGP VL0612	477		62,1		18,7		18,7		12,0	6,3		
PGP VL1218	39		4,8		4,2		4,2		2,8	1,3		
PS VL1218	13		1,2		2,4		2,4		1,2	0,4		
PS VL1824	6		0,6		2,2		2,2		1,5	0,9		
PS VL2440	9		0,6		3,2		3,2		2,3	1,3		
TM VL1824	10		1,8		2,4		2,4		1,2	0,7		

12.7.6 GFCM GSA 17

12.7.6.1 Fleet structure

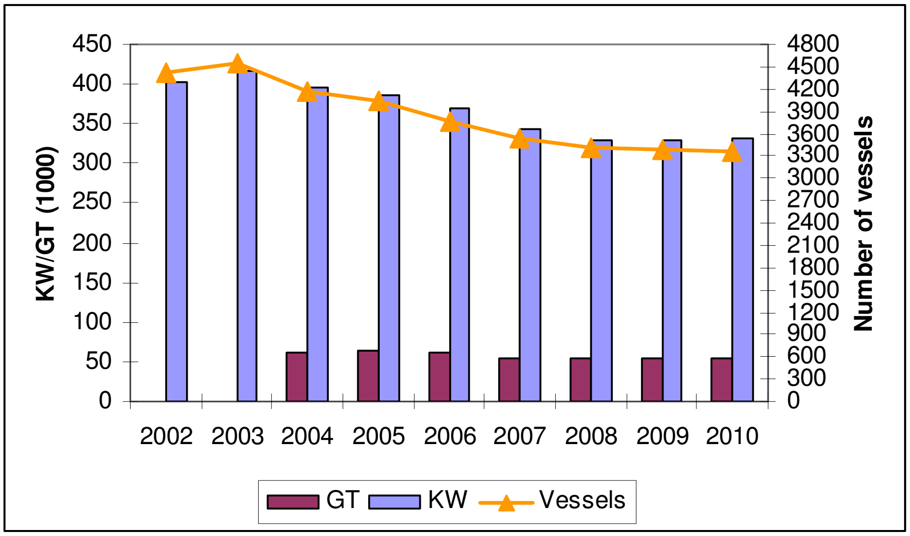

Figure 12.7.6.1.1 GFCM GSA 17 fleet capacity trends

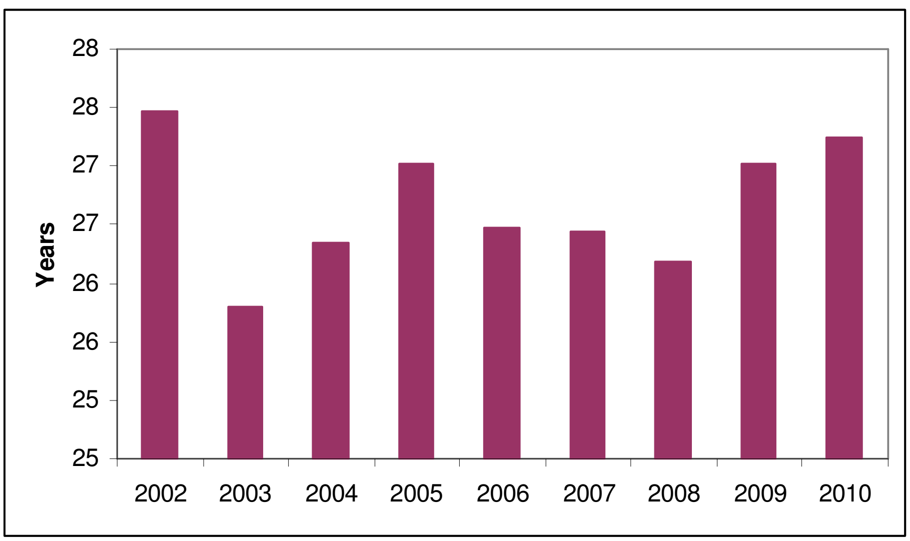

Figure 12.7.6.1.2 GFCM GSA 17 fleet age trend

Figure 12.7.6.1.3 GFCM GSA 17 fishing enterprise categories in 2010 is not available.

Figure 12.7.6.1.3.4 GFCM GSA 17 fleet employment trends

12.7.6.2 Fishing activity

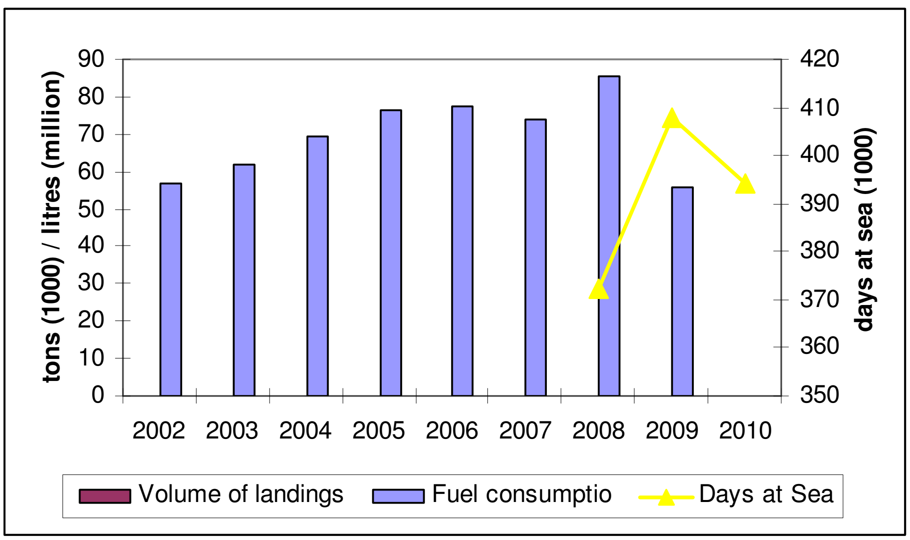

Figure 12.7.6.2.1 GFCM GSA 17 fleet days at sea, fuel use, volume landed trends

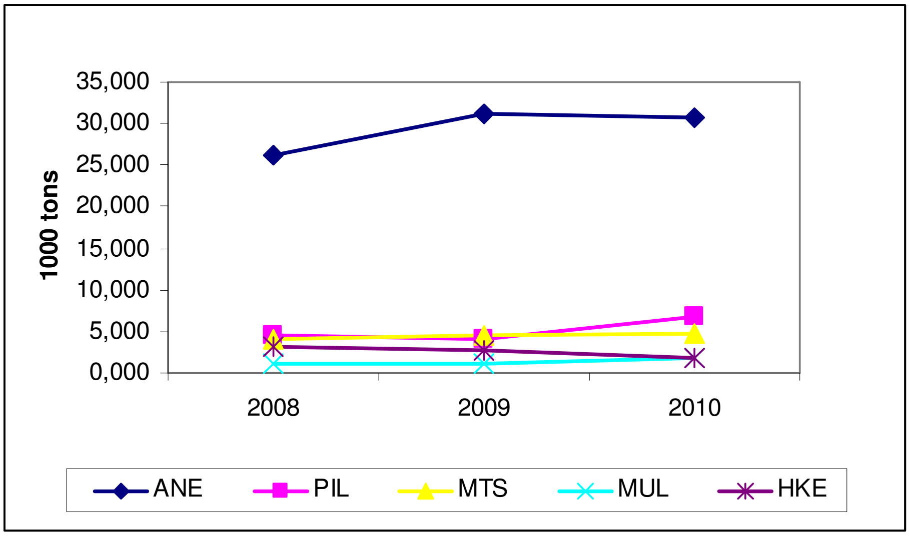

Figure 12.7.6.2.2 GFCM GSA 17 fleet top 5 species landed by volume trends

12.7.6.3 Economic performance

12.7.6.3.1 Landing values and prices

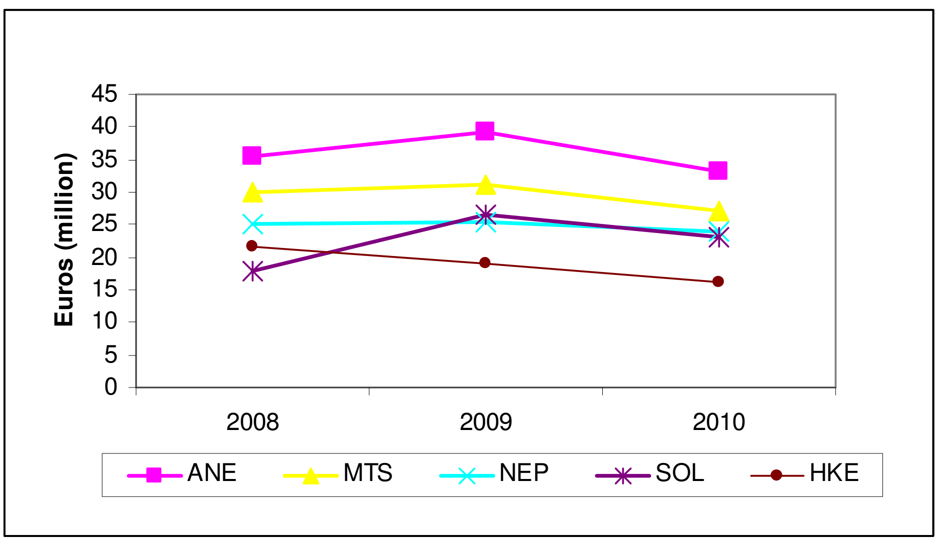

Figure 12.7.6.3.1.1 GFCM GSA 17 fleet top 5 species landed by value trends

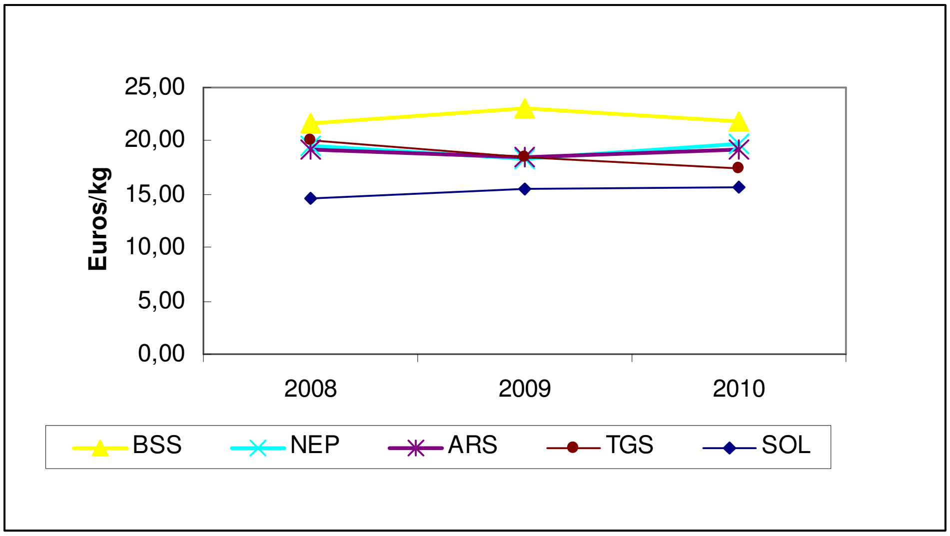

Figure 12.7.6.3.1.2 GFCM GSA 17 fleet price trends of top 5 species landed by value

12.7.6.3.2 Income

Table 12.7.6.3.2.1 GFCM GSA 17 fleet costs, earnings and profitability 2010

	Total (million euros)	% of total income
INCOME		
Value of landings	322,52	100%
Income from fishing rights	0,00	0%
Direct subsidies	n.a.	
Other income	0,00	0%
TOTAL INCOME	322,52	100%
EXPENDITURE		
Energy (fuel) costs	66,22	21%
Repair costs	12,36	4%
Variable costs	31,51	10%
Non variable costs	11,10	3%
Expenditure on fishing rights	0,00	0%
Crew wages	93,19	29%
OPERATING CASH FLOW (OCF)	108,14	34%
Unpaid value of labour	0,00	0%
Depreciation	n.a.	
Interest (opportunity cost of capital)	n.a.	
ECONOMIC PROFIT / LOSS	n.a.	
GROSS VALUE ADDED (GVA)	201,33	62%
TANGIBLE ASSESTS VALUE	n.a.	
RETURN ON FIXED TANGIBLE ASSETS	n.a.	
FISHING RIGHTS VALUE	0,00	

* Direct subsidies is not included.

12.7.6.3.3 Expenditure

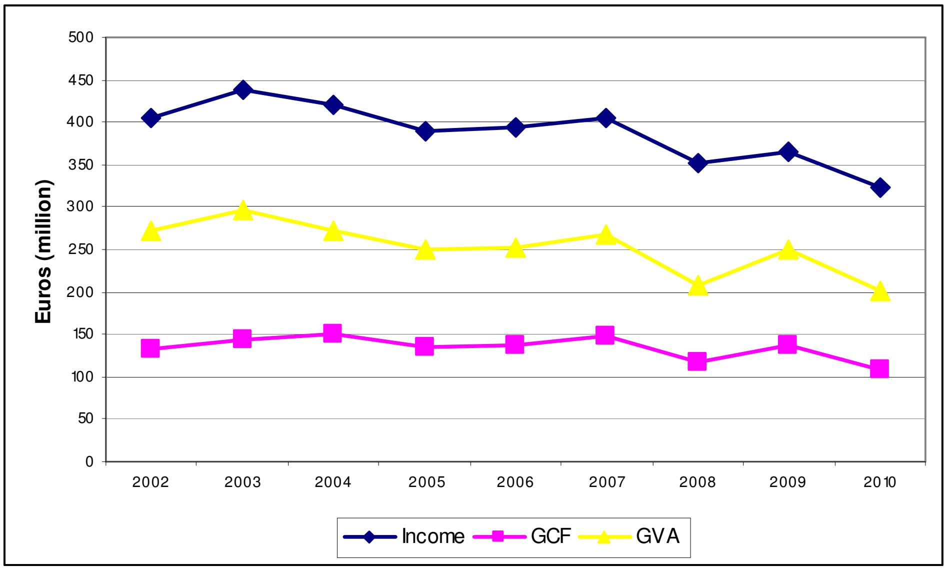

Figure 12.7.6.3.3.1 GFCM GSA 17 fleet key economic performance indicators

12.7.6.3.4 Profitability

12.7.6.4 Fleet composition

Table 12.7.6.4.1 GFCM GSA 17 fleet composition and key indicators in 2010

Fleet segment	Number of vessels	FTEs	Days at Sea (1000 days)	Volume of landings (1000 tons)	Value of landings (million euros)	Direct subsidies (million euros)	Total Income (million euros)	Average wage per FTE (euros)	GVA (million euros)	Operating cash flow (million euros)	Profit / loss (million euros)	Capital Value (million euros)
DRB VL1218	587		52,8		55,4		55,4		41,8	23,5		
DTS VL0612	66		6,3		3,4		3,4		1,7	0,7		
DTS VL1218	358		43,5		51,1		51,1		29,2	15,6		
DTS VL1824	194		27,7		58,1		58,1		32,6	16,9		
DTS VL2440	57		7,7		23,3		23,3		12,9	7,4		
PGP VL0006	727		80,2		18,0		18,0		14,3	8,6		
PGP VL0612	1124		141,9		48,7		48,7		34,2	19,9		
PGP VL1218	7		1,6		3,0		3,0		2,6	1,6		
PMP VL0612	23		2,8		0,9		0,9		0,6	0,3		
PS VL1218	18		1,1		1,5		1,5		0,9	0,4		
PS VL1824	4		0,2		0,7		0,7		0,2	-0,1		
PS VL2440	17		1,4		4,5		4,5		2,3	1,0		
TBB VL1218	12		1,4		1,6		1,6		0,8	0,3		
TBB VL1824	26		3,8		5,4		5,4		2,0	0,4		
TBB VL2440	34		5,1		12,4		12,4		6,7	3,5		
TM VL1218	37		5,8		8,6		8,6		5,4	2,2		
TM VL1824	25		4,2		9,1		9,1		5,3	2,5		
TM VL2440	40		6,8		16,6		16,6		7,9	3,5		

12.7.7 GFCM SA 18

12.7.7.1 Fleet structure

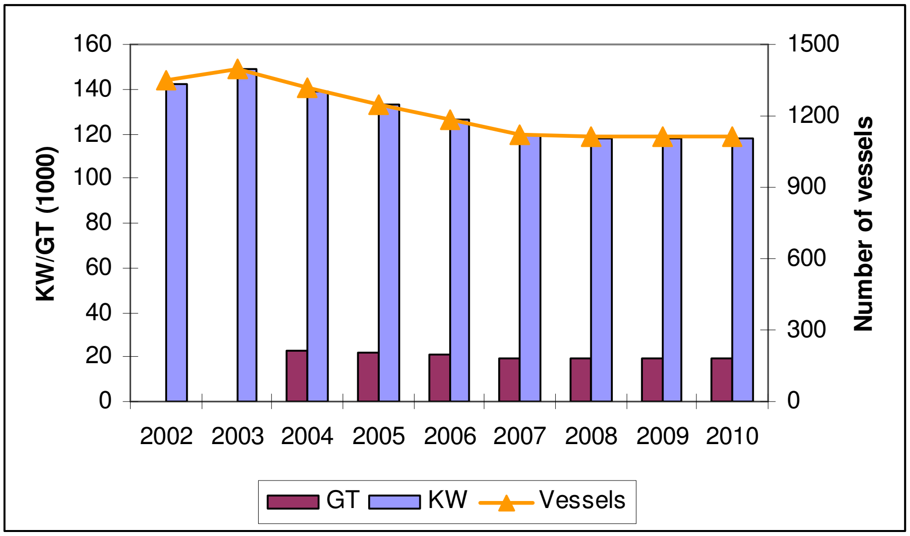

Figure 12.7.7.1.1 GFCM GSA 18 fleet capacity trends

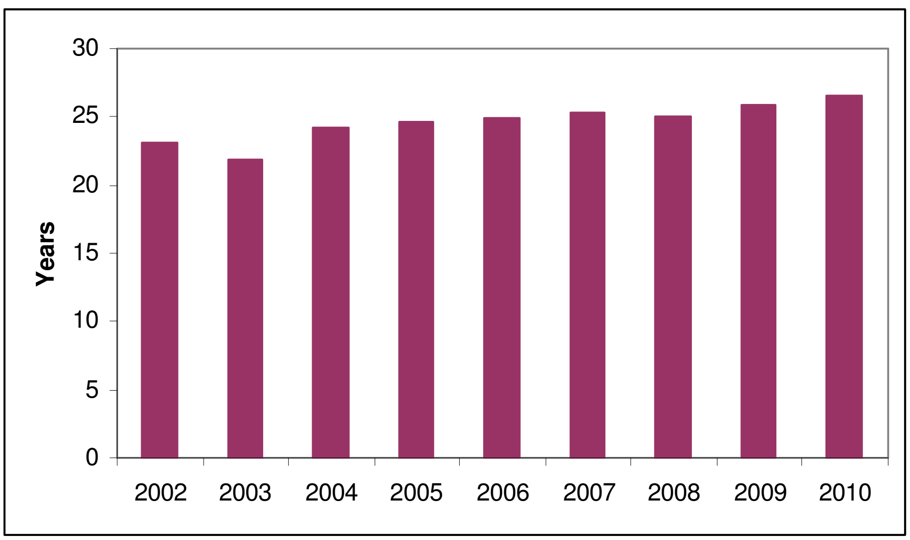

Figure 12.7.7.1.2 GFCM GSA 18 fleet age trend

Figure 12.7.7.1.3 GFCM GSA 18 fishing enterprise categories in 2010 is not available.

Figure 12.7.7.1.4 GFCM GSA 18 fleet employment trends

12.7.7.2 Fishing activity

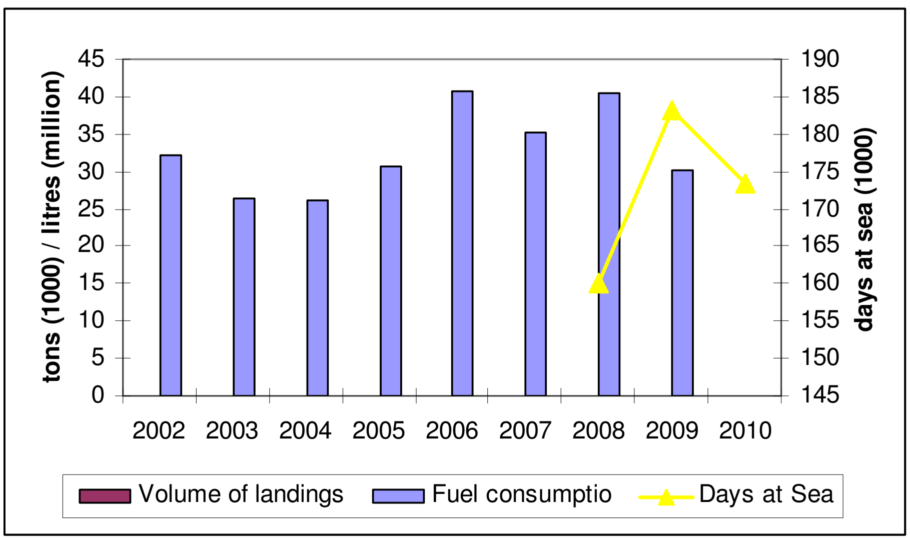

Figure 12.7.7.2.1 GFCM GSA 18 fleet days at sea, fuel use, volume landed trends

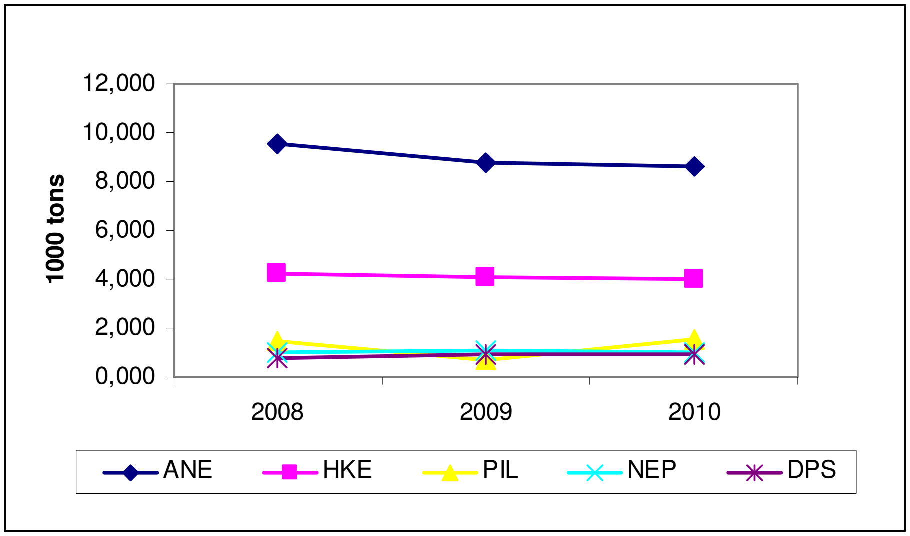

Figure 12.7.7.2.2 GFCM GSA 18 fleet top 5 species landed by volume trends

12.7.7.3 Economic performance

12.7.7.3.1 Landing values and prices

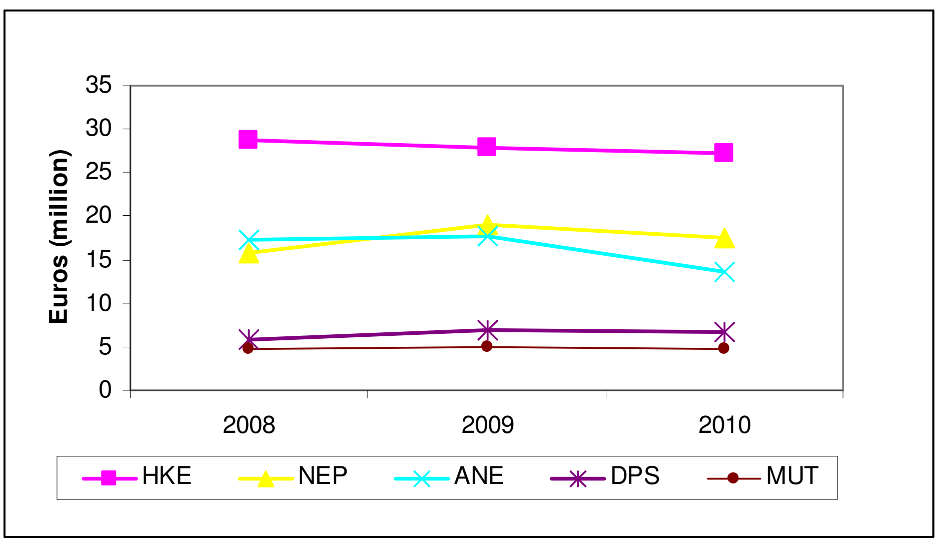

Figure 12.7.7.3.1.1 GFCM GSA 18 fleet top 5 species landed by value trends

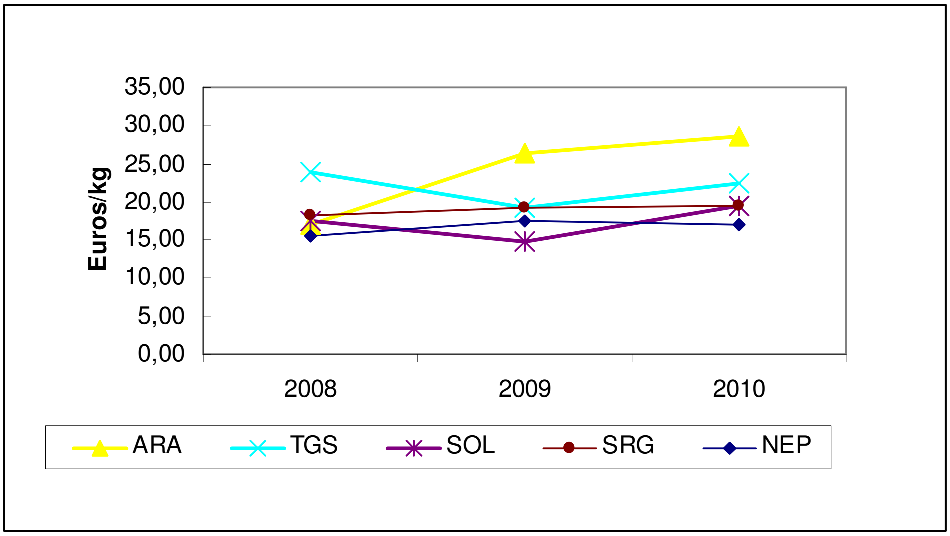

Figure 12.7.7.3.1.2 GFCM GSA 18 fleet price trends of top 5 species landed by value

12.7.7.3.2 Income

Table 12.7.7.3.2.1 GFCM GSA 18 fleet costs, earnings and profitability 2010

	Total (million euros)	% of total income
INCOME		
Value of landings	143,09	100%
Income from fishing rights	0,00	0%
Direct subsidies	n.a.	
Other income	0,00	0%
TOTAL INCOME	143,09	100%
EXPENDITURE		
Energy (fuel) costs	34,07	24%
Repair costs	4,89	3%
Variable costs	15,93	11%
Non variable costs	5,10	4%
Expenditure on fishing rights	0,00	0%
Crew wages	41,75	29%
OPERATING CASH FLOW (OCF)	41,35	29%
Unpaid value of labour	0,00	0%
Depreciation	n.a.	
Interest (opportunity cost of capital)	n.a.	
ECONOMIC PROFIT / LOSS	n.a.	
GROSS VALUE ADDED (GVA)	83,10	58%
TANGIBLE ASSESTS VALUE	n.a.	
RETURN ON FIXED TANGIBLE ASSETS	n.a.	
FISHING RIGHTS VALUE	0,00	

* Direct subsidies is not included.

12.7.7.3.3 Expenditure

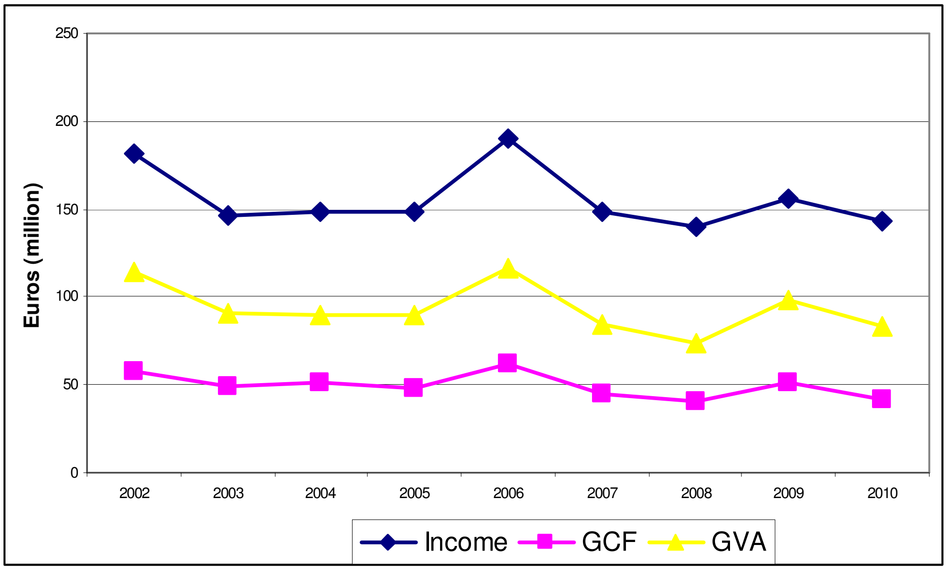

Figure 12.7.7.3.3.1 6.9 GFCM GSA 18 fleet key economic performance indicators

12.7.7.3.4 Profitability

12.7.7.4 Fleet composition

Table 12.7.7.4.1 GFCM GSA 18 fleet composition and key indicators in 2010

Fleet segment	Number of vessels	FTEs	Days at Sea (1000 days)	Volume of landings (1000 tons)	Value of landings (million euros)	Direct subsidies (million euros)	Total Income (million euros)	Average wage per FTE (euros)	GVA (million euros)	Operating cash flow (million euros)	Profit / loss (million euros)	Capital Value (million euros)
DRB VL1218	76		6,2		5,3		5,3		4,1	2,2		
DTS VL0612	38		5,2		4,3		4,3		2,4	1,2		
DTS VL1218	305		48,4		59,1		59,1		36,3	18,0		
DTS VL1824	90		15,1		25,2		25,2		12,2	6,7		
DTS VL2440	30		4,4		10,0		10,0		4,8	2,2		
HOK VL1218	41		4,8		7,5		7,5		5,1	2,6		
PGP VL0006	180		31,7		4,6		4,6		3,5	1,7		
PGP VL0612	311		52,0		11,8		11,8		7,4	3,5		
PS VL2440	7		0,6		3,1		3,1		1,9	0,8		
TM VL2440	34		4,9		12,2		12,2		5,5	2,5		

12.7.8 GFCM SA 19

12.7.8.1 Fleet structure

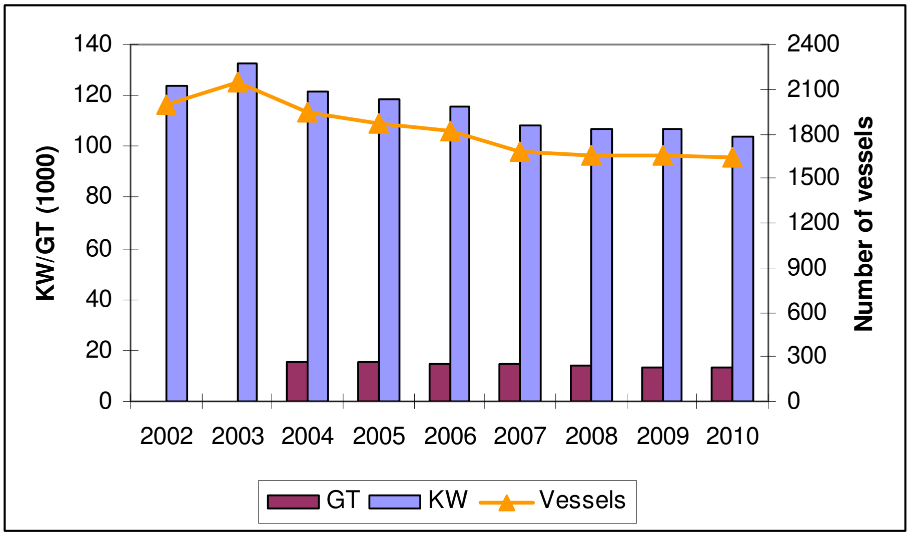

Figure 12.7.8.1.1 GFCM GSA 19 fleet capacity trends

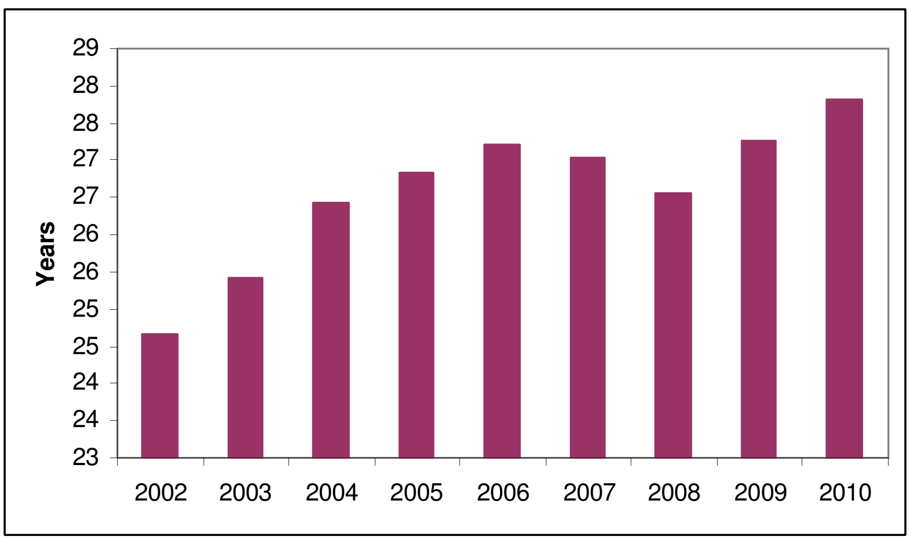

Figure 12.7.8.1.2 GFCM GSA 19 fleet age trend

Figure 12.7.8.1.3 GFCM GSA 19 fishing enterprise categories in 2010 is not available.

Figure 12.7.8.1.4 GFCM GSA 19 fleet employment trends

12.7.8.2 Fishing activity

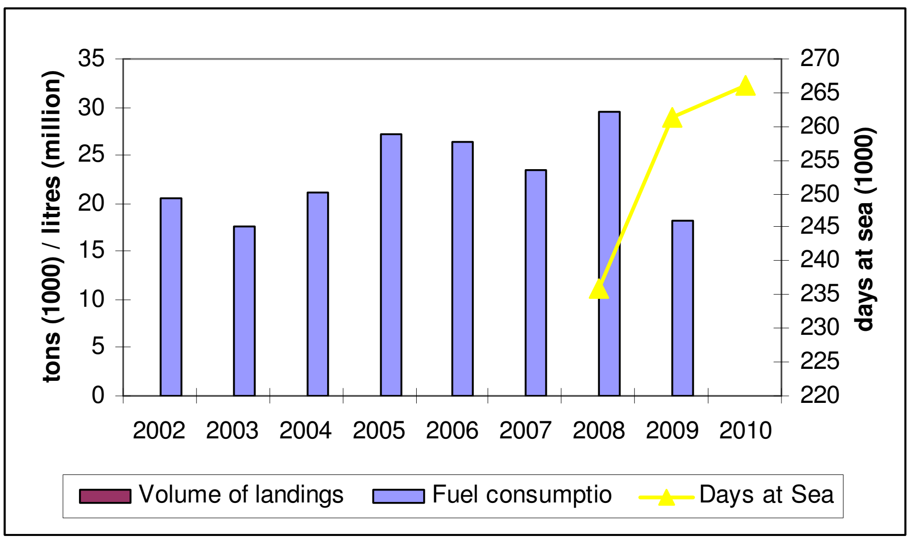

Figure 12.7.8.2.1 GFCM GSA 19 fleet days at sea, fuel use, volume landed trends

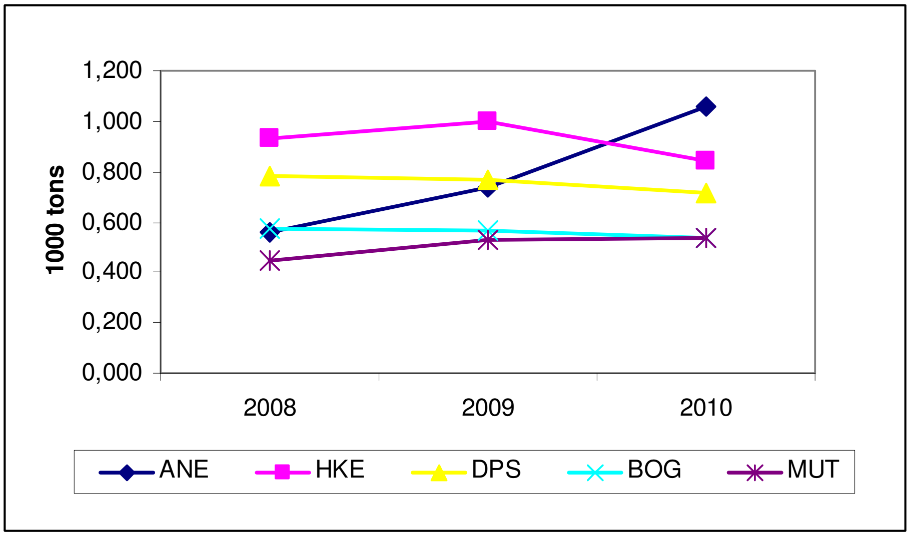

Figure 12.7.8.2.2 GFCM GSA 19 fleet top 5 species landed by volume trends

12.7.8.3 Economic performance

12.7.8.3.1 Landing values and prices

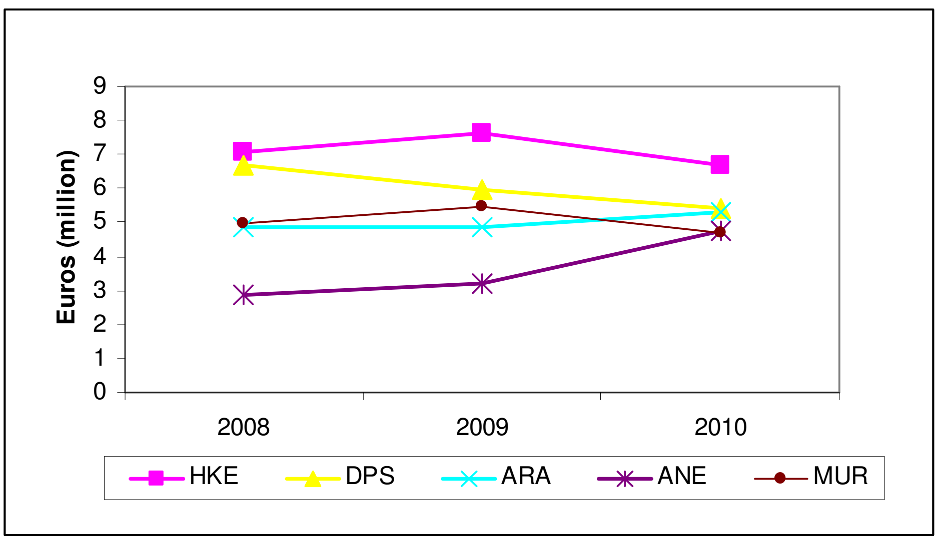

Figure 12.7.8.3.1.1 GFCM GSA 19 fleet top 5 species landed by value trends

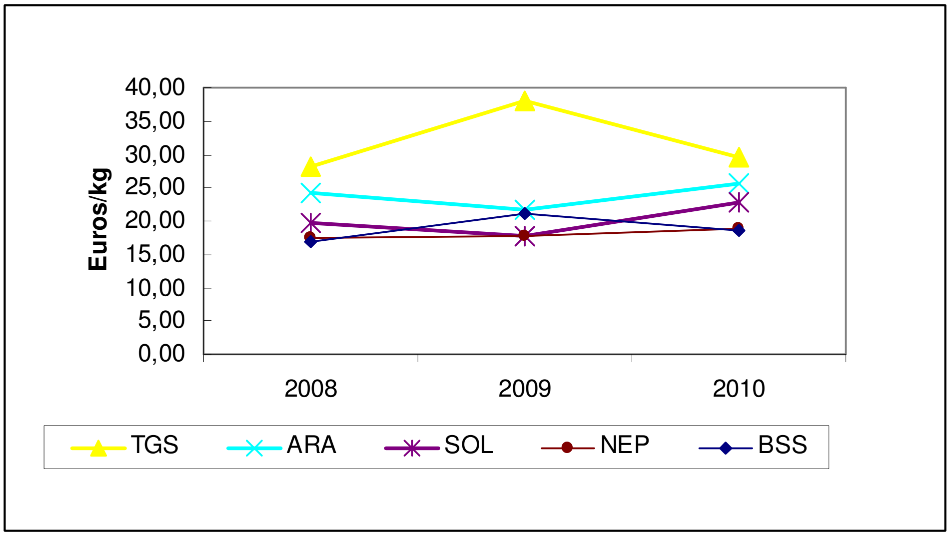

Figure 12.7.8.3.1.2 GFCM GSA 19 fleet price trends of top 5 species landed by value

12.7.8.3.2 Income

Table 12.7.8.3.2.1 GFCM GSA 19 fleet costs, earnings and profitability 2010

	Total (million euros)	% of total income
INCOME		
Value of landings	124,36	100%
Income from fishing rights	0,00	0%
Direct subsidies	n.a.	
Other income	0,00	0%
TOTAL INCOME	124,36	100%
EXPENDITURE		
Energy (fuel) costs	23,25	19%
Repair costs	4,77	4%
Variable costs	19,76	16%
Non variable costs	3,96	3%
Expenditure on fishing rights	0,00	0%
Crew wages	39,89	32%
OPERATING CASH FLOW (OCF)	32,73	26%
Unpaid value of labour	0,00	0%
Depreciation	n.a.	
Interest (opportunity cost of capital)	n.a.	
ECONOMIC PROFIT / LOSS	n.a.	
GROSS VALUE ADDED (GVA)	72,62	58%
TANGIBLE ASSESTS VALUE	n.a.	
RETURN ON FIXED TANGIBLE ASSETS	n.a.	
FISHING RIGHTS VALUE	0,00	

* Direct subsidies is not included.

12.7.8.3.3 Expenditure

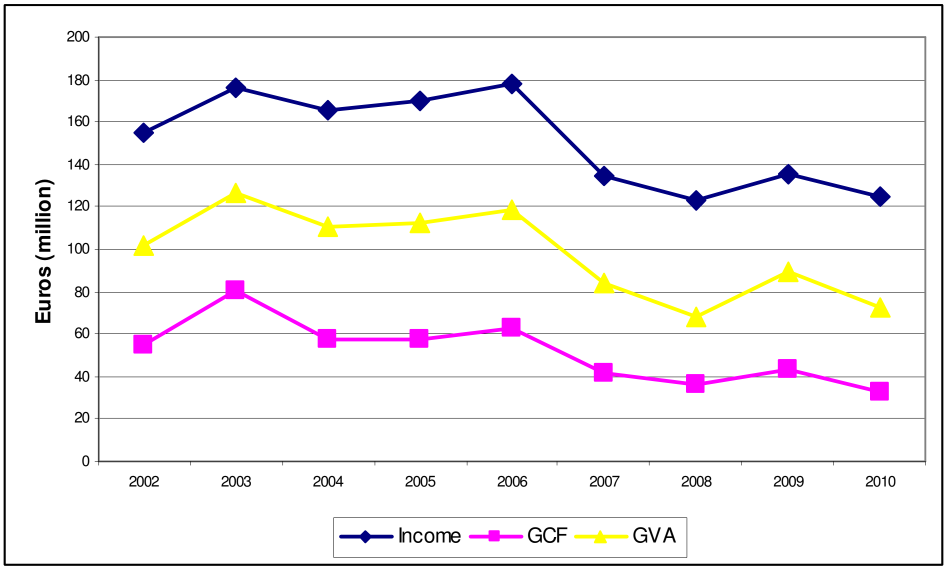

Figure 12.7.8.3.3.1 GFCM GSA 19 fleet key economic performance indicators

12.7.8.3.4 Profitability

12.7.8.4 Fleet composition

Table 12.7.8.4.1 GFCM GSA 19 fleet composition and key indicators in 2010

Fleet segment	Number of vessels	FTEs	Days at Sea (1000 days)	Volume of landings (1000 tons)	Value of landings (million euros)	Direct subsidies (million euros)	Total Income (million euros)	Average wage per FTE (euros)	GVA (million euros)	Operating cash flow (million euros)	Profit / loss (million euros)	Capital Value (million euros)
DTS VL1218	225		38,5		31,2		31,2		16,6	6,7		
DTS VL1824	24		4,4		6,4		6,4		3,8	1,2		
HOK VL1218	29		4,5		6,0		6,0		3,9	1,1		
HOK VL1824	35		6,3		9,8		9,8		3,8	1,6		
PGP VL0006	422		56,0		10,6		10,6		7,5	3,4		
PGP VL0612	769		130,5		37,6		37,6		27,8	14,1		
PGP VL1218	124		22,0		19,1		19,1		7,5	3,8		
PS VL1218	20		3,9		3,6		3,6		1,7	0,7		

12.7.9 Conclusions

The analysis performed at GFCM GSA level has allowed highlighting some deficiencies in the Mediterranean data call with reference to the economic data, which can be easily overcame by changing the data call accordingly with the outcomes presented in this document. In particular, the following points should be taken into account:

- FTE should be requested for the period 2002-2010;
- Days at sea should be requested for the period 2002-2010;
- Total (all species) landings in weight and value should be requested for the period 2002-2010;
- Total (all species) landings in weight and value should be requested also by fleet segment for the period 2002-2010;
- Landings in weight and value by species should be requested also by fleet segment for the period 2002-2010;
- Landings in weight and value by species should be requested by fishing gear and by fleet segment for the period 2002-2010;
- Data on the composition of fishing enterprises in terms of number of vessels owned should be requested for the last year at least.

An additional point is related to the time needed to collect and elaborate some economic data after the reference period. In the definition of the Mediterranean data call, this issue should be taken into account as well.

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15 ANNEX II AGE SLICING METHOD

Comparison of age slicing methods by Finlay Scott, Chato Osio and Max Cardinale can be downloaded from the STECF meeting's web site

https://stecf.jrc.ec.europa.eu/reports/medbs

16 LIST OF BACKGROUND DOCUMENTS

Background documents are published on the meeting's web site on: https://stecf.jrc.ec.europa.eu/meetings/2011

List of background documents:

1. EWG-11-12 – Doc 1 - Declarations of invited and JRC experts.

European Commission

EUR 25053 EN **– Joint Research Centre – Institute for the Protection and Security of the Citizen**

Title: Scientific, Technical and Economic Committee for Fisheries. Assessment of Mediterranean Sea stocks - part 2 (STECF-11-14).

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Abstract

In accordance with the ToR the STECF reviewed the report of its EWG 11-12 which provides advice on Mediteranean stocks and fisheries, informs about the state of the art regarding the development of specific computer software to facilitate consistent evaluation of commercial and scientific catches, provides exemplified multi-species fisheries management options, and provisionally concludes on certain fisheries technical issues and the Maltese fisheries management plan 2011-15. The specific findings of the EWG 11-12 are endorsed by STECF.

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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